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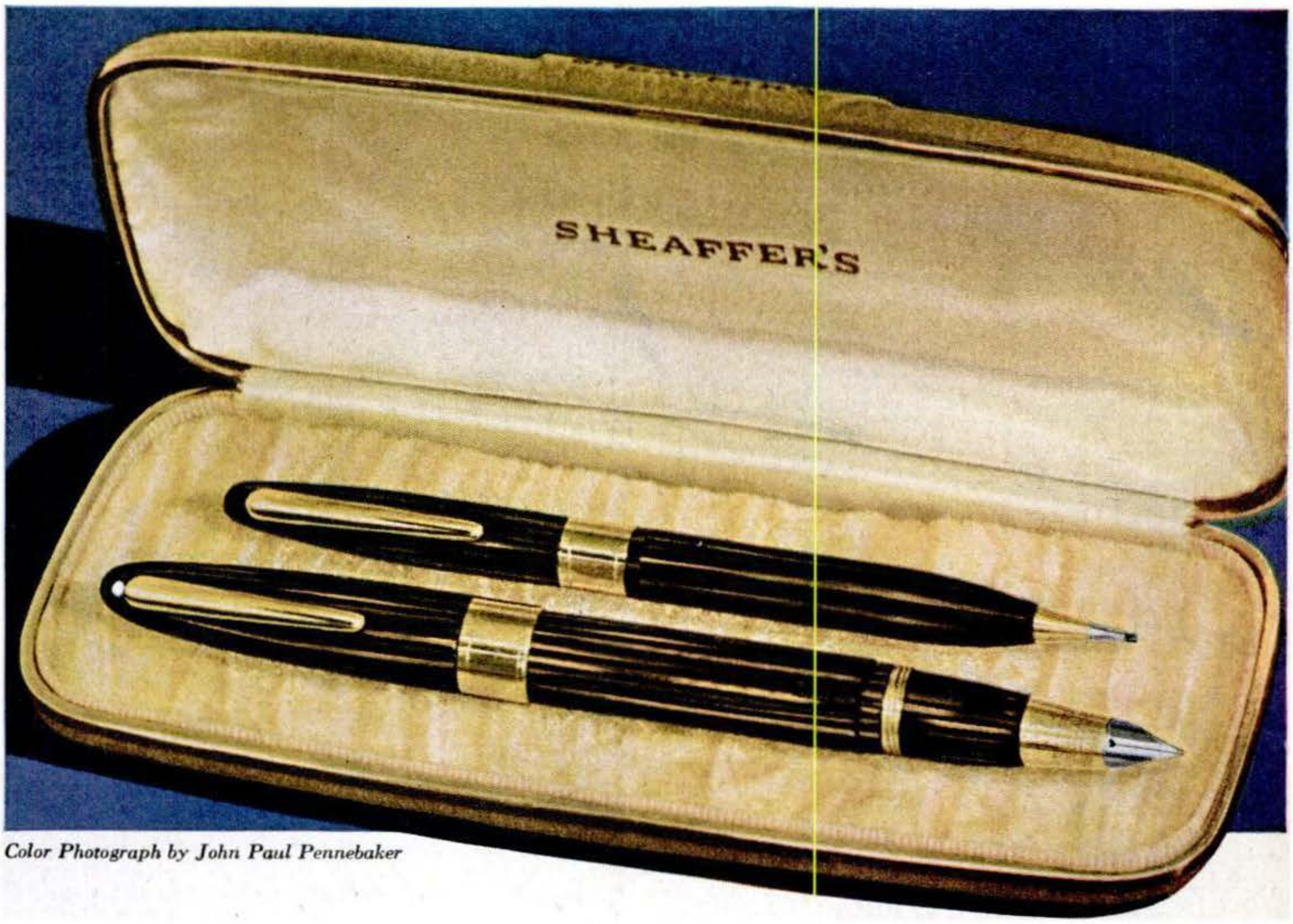

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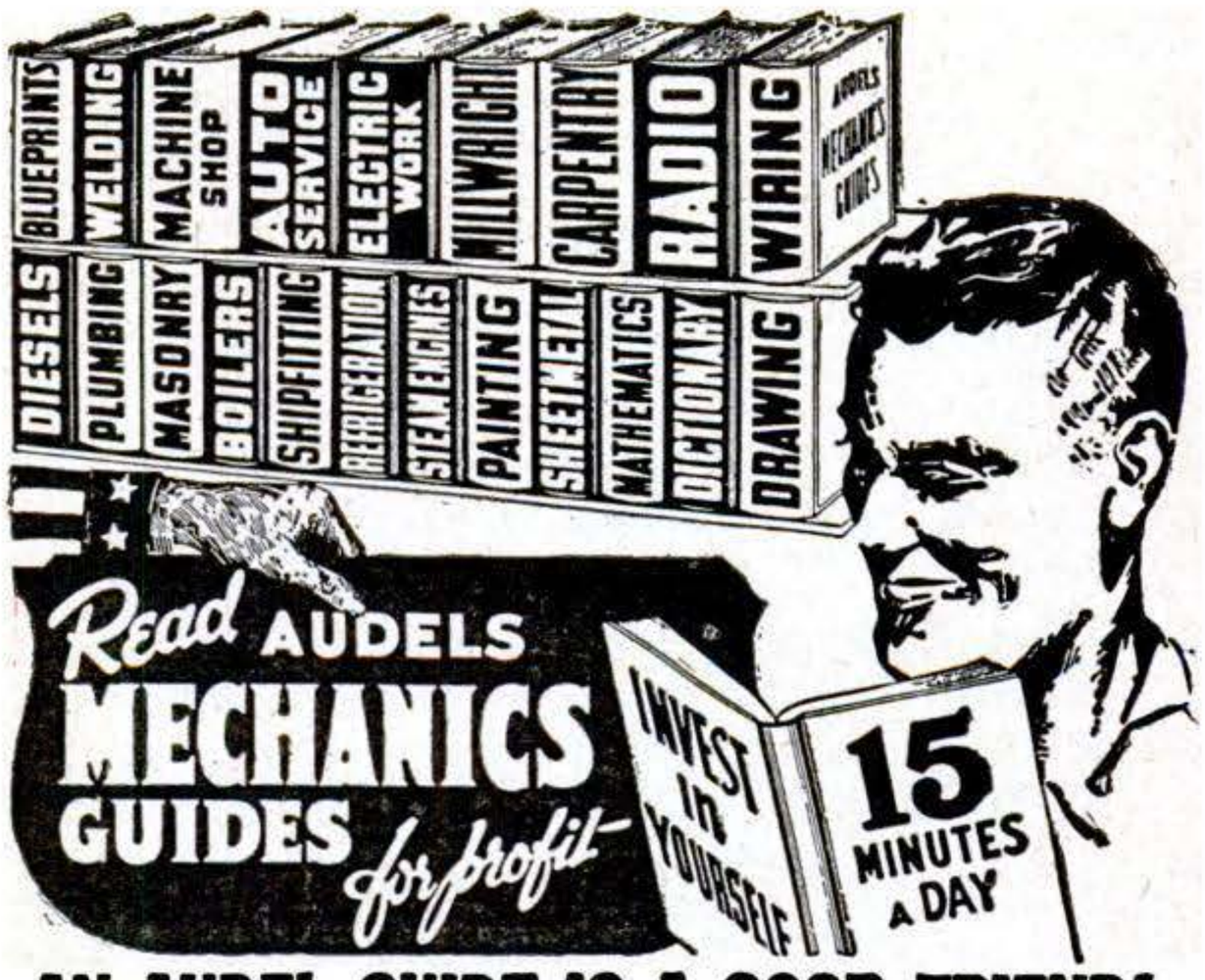

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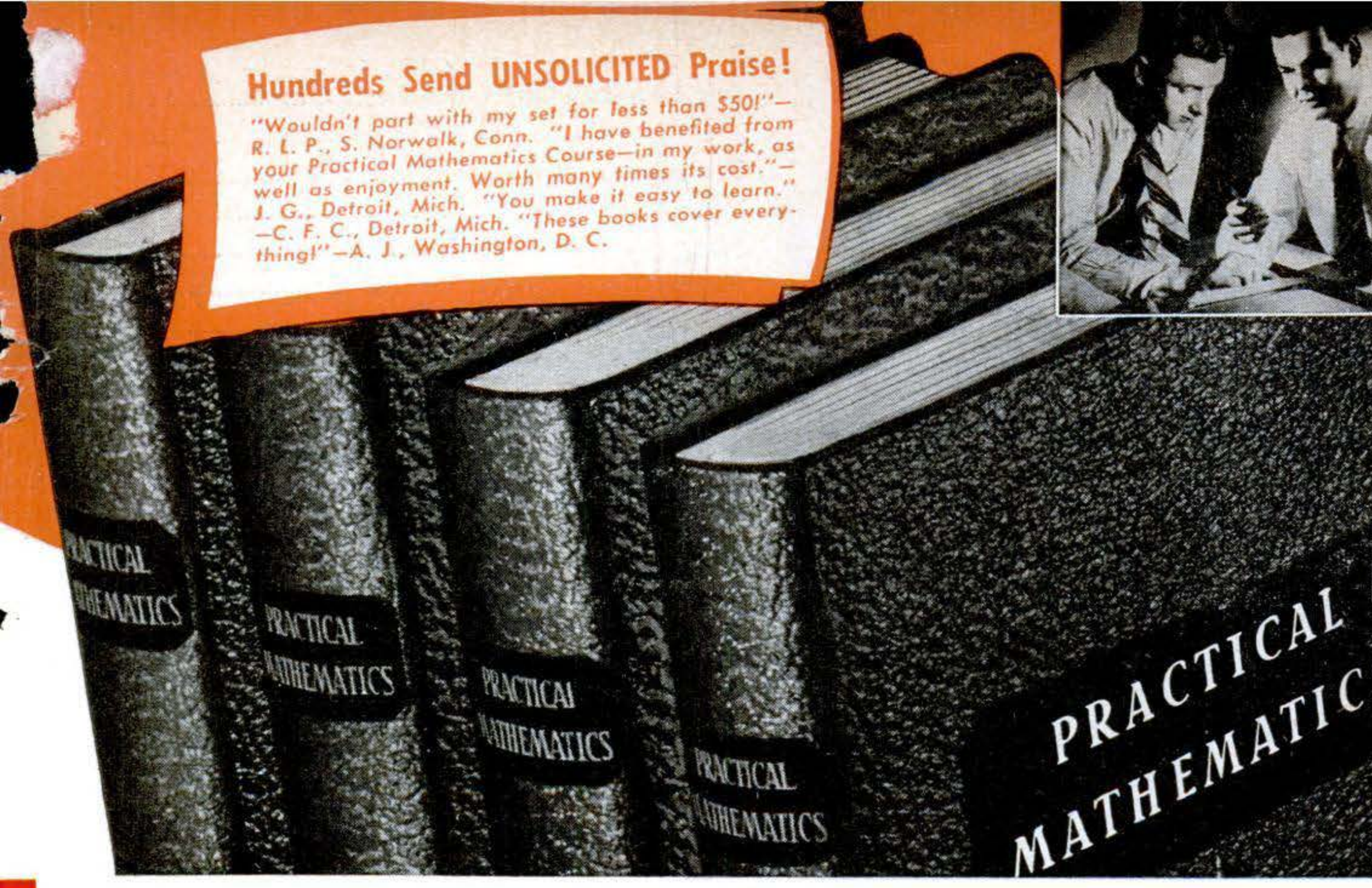

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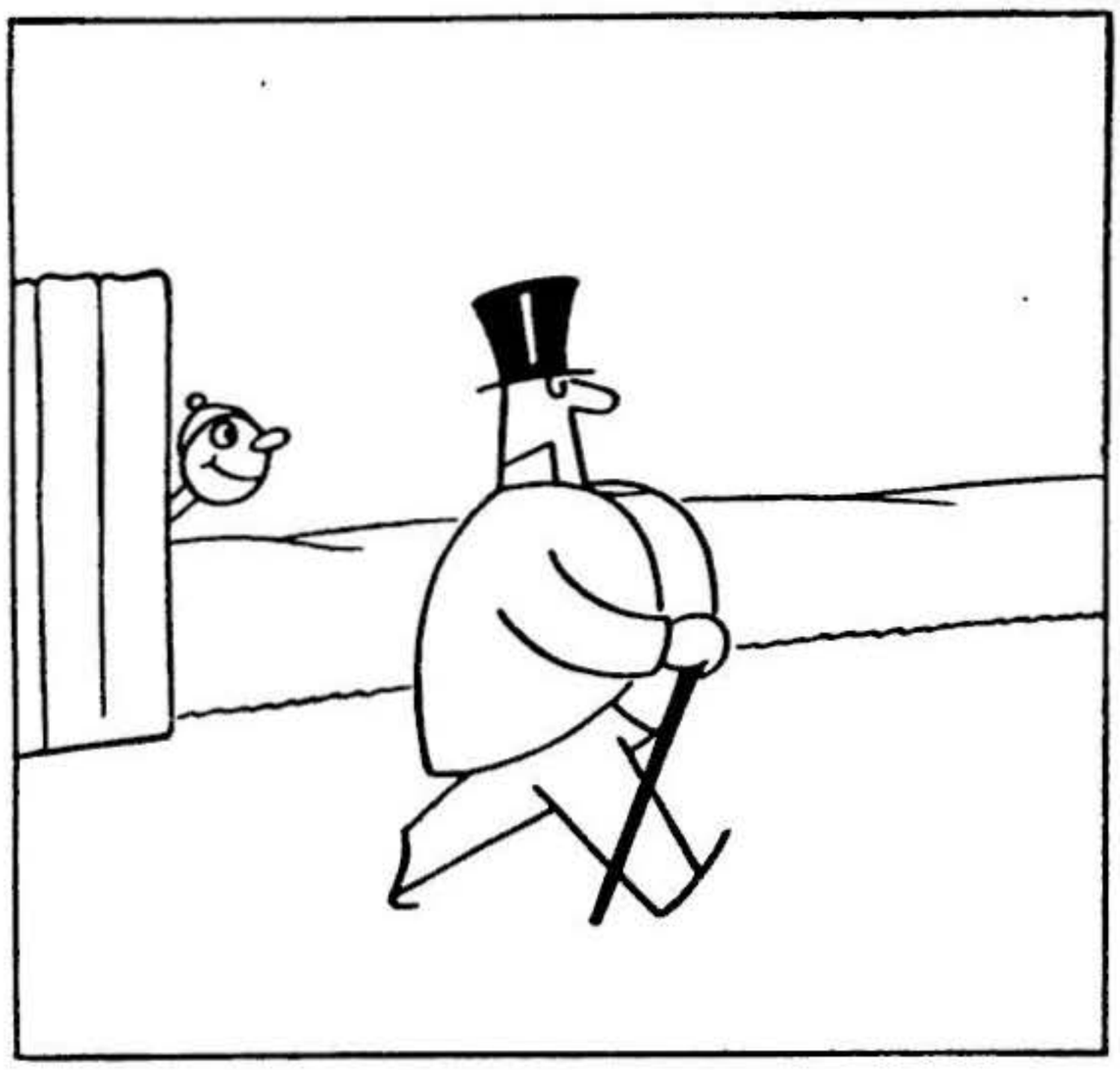

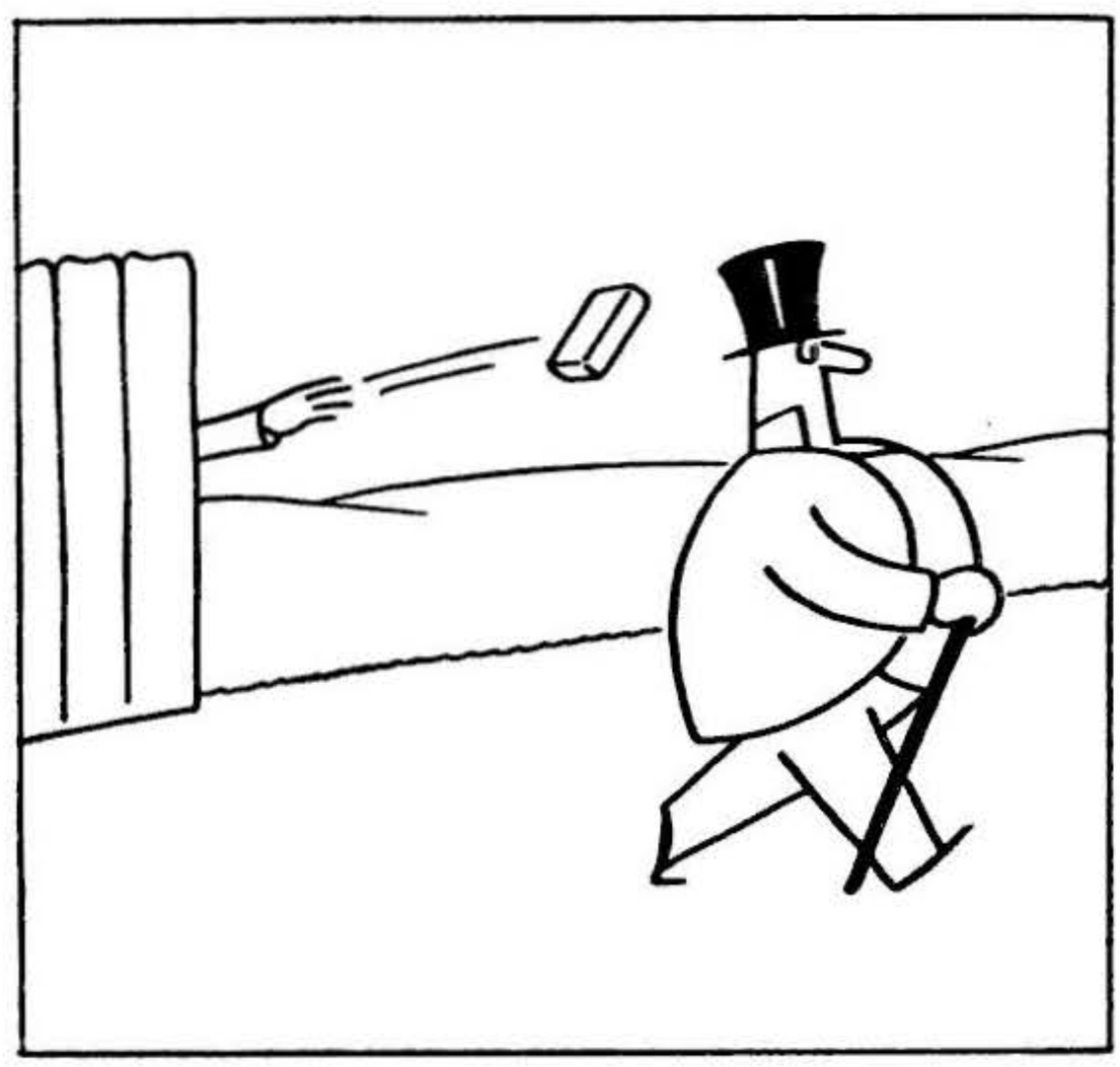

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SHORAN—a surveying system with pin-point accuracy!

One small error in a map can be costly in the location of an oil well or mining property. But with Shoran, vast areas can now be charted by plane with an error of less than twelve inches in five miles—and in a matter of minutes or hours as opposed to weeks or months that would be required by laborious surveys made on the ground. Shoran is called one of the most important geographic inventions since the compass.

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Just as Shoran is a revolutionary stride forward in map-making, so do all RCA products represent the farthest point of progress in their fields.

And when you buy anything made by RCA or RCA Victor, you are sure of getting one of the finest instruments of its kind science has achieved.

Radio Corporation of America, RCA Building, Radio City, New York 20. Listen to The RCA Victor Show, Sundays, 2:00 P. M., Eastern Daylight Time, over the NBC Network.

Until recently a closely guarded military secret, Shoran was developed at RCA Laboratories—a world center of radio and electronic research. The same skills that developed Shoran keep RCA and RCA Victor outstanding in radio, broadcasting, television and recorded entertainment.

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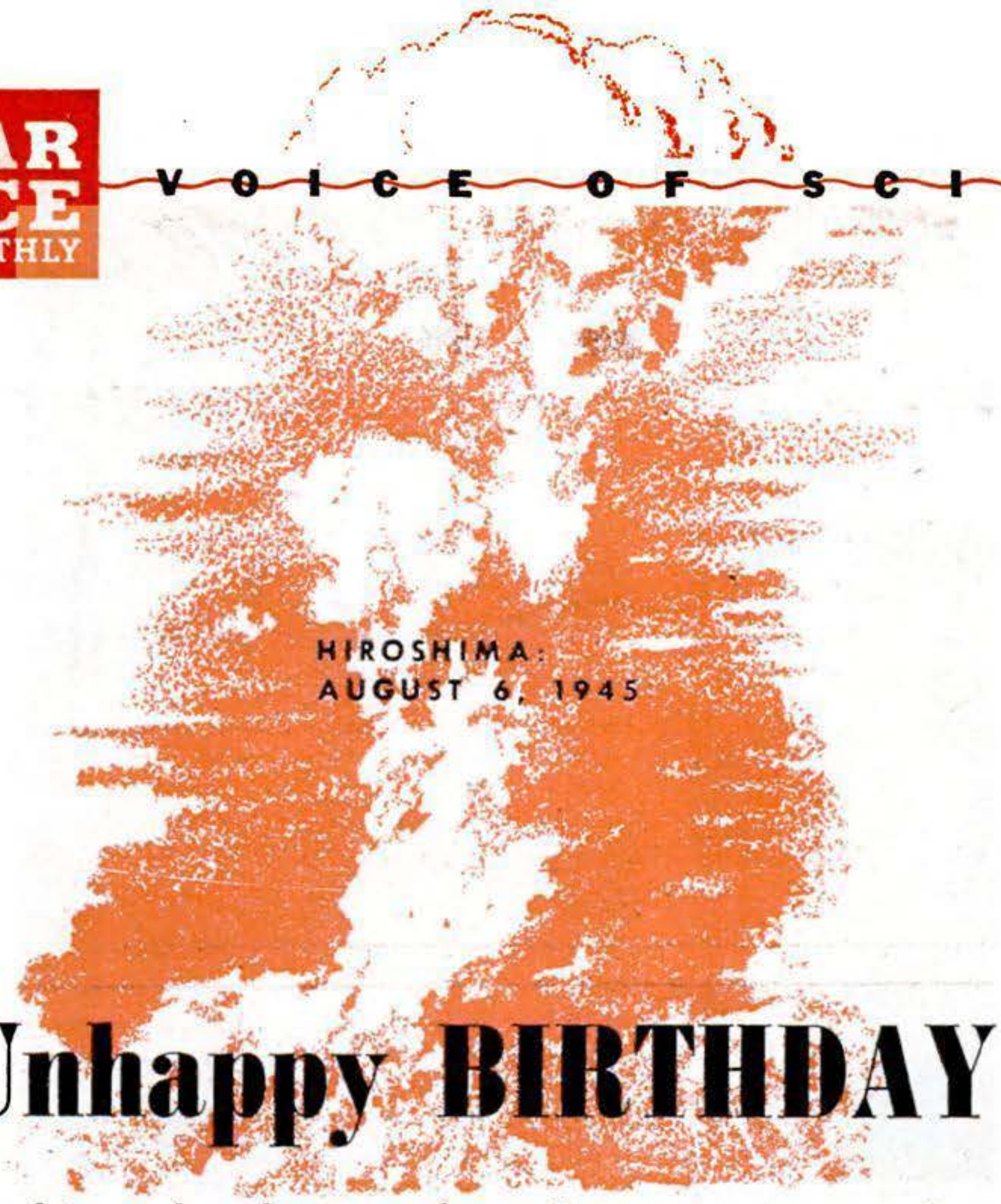

Unhappy BIRTHDAY

A YEAR after Hiroshima, when the news of atomic fission burst upon a wondering world, the working atom is still a weapon of war rather than a power for peace. Man's greatest triumph over matter began as a bomb, and it is still a bomb.

So this has been a lost year, a year of fear, during which atomic power became a political force, overshadowing science, and clouding with ugliness both national and international affairs.

The very scientists who brought the bomb into being have been shackled to it by military secrecy. The very applications of atomic energy to the health and wealth of the world that might make war obsolete have been halted. The great new power of science has been seized by politicians and diplomats.

Some scientists, frightened into understanding of their enormous social responsibility, have tried to arouse their fellow countrymen to the dangers of old-fashioned thinking in the huge new dimensions of nuclear physics. But they could not stop the blast at Bikini. They will need help to halt future political demonstrations of atomic power. They need your help.

For if atomic energy has been made a political thing to its detriment as a scientific development for your welfare, you can help to free science from politics by using your available political machinery.

You can write your Senators and Representatives urging their support of any bill promising development of atomic energy for civilian uses under civilian control.

You can read the Smyth Report, which told how the bombs were made, and ask yourself — and your Representatives — why there has been no Smyth Report on non-military uses of atomic energy.

You can bet dollars against disaster by subscribing to the work of the National Committee on Atomic Information, 1749 L St., N. W., Washington 6, D. C. This is the clearing house for public information established by some 70 organizations representing scientists, churches, labor unions, and other groups of interested citizens.

You can make yourself politically potent by joining your own neighborhood groups that are trying to educate the public to an understanding of this most vital of problems.

Most of all, you can keep yourself informed. You don't need to be a scientist to be adequately informed as a citizen. You don't need to know *why* or *how* atomic energy works. But you should know *what* has happened, and *what* is involved, if you and the bomb are to enjoy happier birthdays.

Perry Gilkeson

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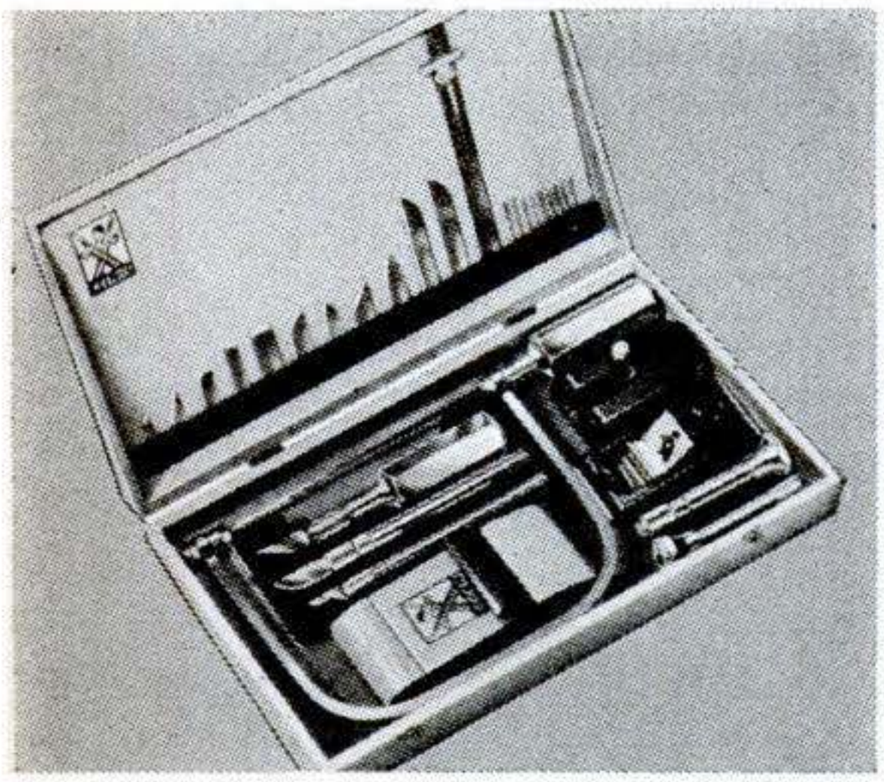
13 Different Blade Shapes

X-acto is always right—always ready!

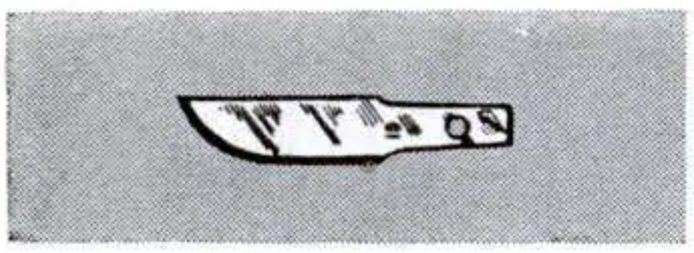
"Like my good right hand..."

That's how much X-acto Knives mean to Martin Prehn, professional artist and expert whittler of Freeport, Long Island. He has used them for years, he says, for both his work and his hobby . . . and finds them *always* sharp, with *always* the needed blade contour."

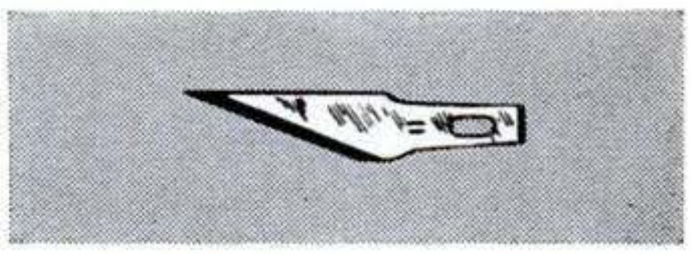
Just look at them — there to the right are the thirteen scientifically designed blade shapes which make X-acto the ideal knife for every art and craft. Each of fine surgical steel, ground scalpel-sharp. With X-acto's three firm-grip, all-metal knives, and an assortment of these versatile, interchangeable blades, even an amateur can tackle any hobby job with confidence and gusto.



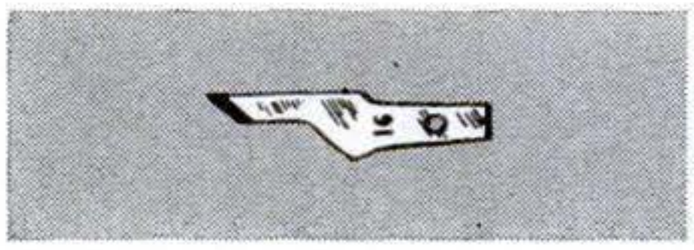
"Small Tools Are a Big Help," says Mr. Prehn. "There are so many small jobs that *only* small tools do *well*. X-acto Tools fit the hobby, and the hand, perfectly." No. 85 X-acto Tool Chest: 3 all-metal Knives; complete blade assortment; planer; sander; stripper; saw; drills; holders; ruler; complete in handy desk-drawer-size wooden chest, $12.50.



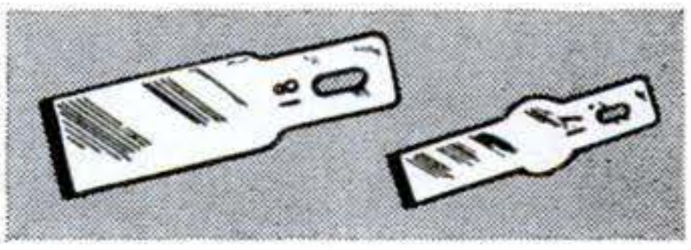
No. 10 — For all small, fine general work, including small concave or convex surfaces.



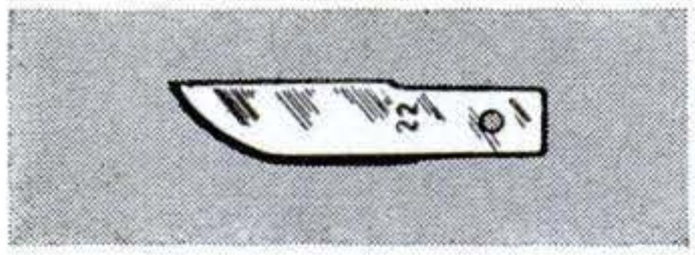
No. 11 — For fine angle cutting and deep cuts in narrow places, with less danger of splitting. Also for stencils.



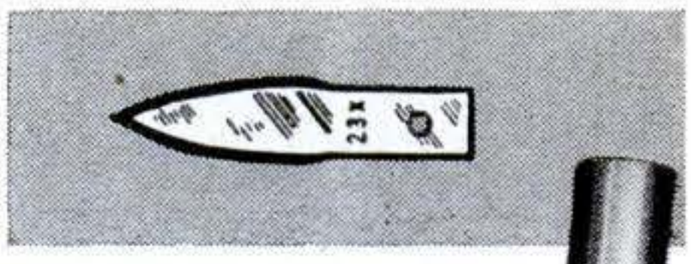
No. 16 — For small holes or notches. Ideal for templates, friskets, or stencils in thin materials, even tracing paper.



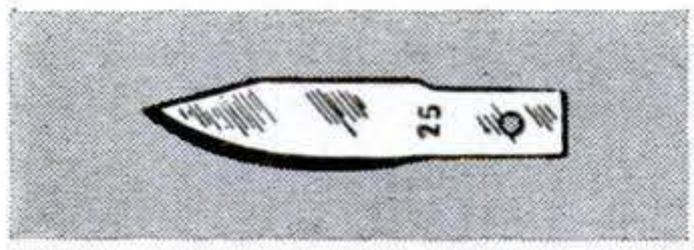
No. 17 — A chisel blade, ¼-inch wide, for working those hard-to-get-at flat surfaces. **No. 18** — Same, ½-inch wide.



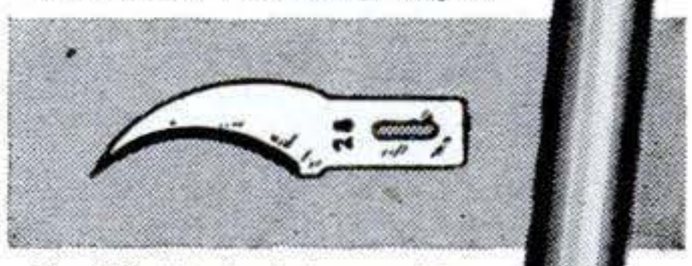
No. 22 — For long cuts along a template, or close corners. For whittling concave or convex surfaces.



No. 23X — Ideal for acute-angled corners. All purpose blade with 2 cutting edges.



No. 25 — The ideal blade for general carving and all outside heavier cutting. Use it with No. 2 or No. 6 Knife.



No. 28—Hooked, for outside curved shaping. For leather, linoleum, whittling.

No. 24—For light chiseling, close corners. Templates and mats of cardboard, paper, celluloid. Cross grain trims, etc.

No. 19—A broader blade for general roughing, deep scoring and cross cutting.

No. 26—3-inch whittler's blade. **No. 27** — 3-inch saw blade.

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Have you a desire, *something you wish to accomplish* in life? Put your finger on a dot. In whatever direction you move your finger from the dot, you have made a beginning. Thus a dot is the symbol of *one*—or a beginning. Your desire then is also symbolized by *one*. If you follow the *proper method* or way to accomplish what you want, you have arrived at point *two*. Whenever these two symbols are brought together—the idea and the right way—you produce point *three*—the success of your plan. Success, therefore, is symbolized by the three equal sides of a *triangle*.

In planning your personal affairs—business, domestic, or the welfare of your family—do you use a *Cosmic formula?* Do you determine whether your acts are in accord with Divine truths eternally expressed in symbols? Why does the circle represent completion? Why is it said that a man is on the square? These symbols are used by astronomers and scientists to prove the physical laws of the universe—why don't you apply them to the problems of your everyday world? Learn what symbols, as powers and forces of nature, you can simply and intelligently use in directing the course of your life.

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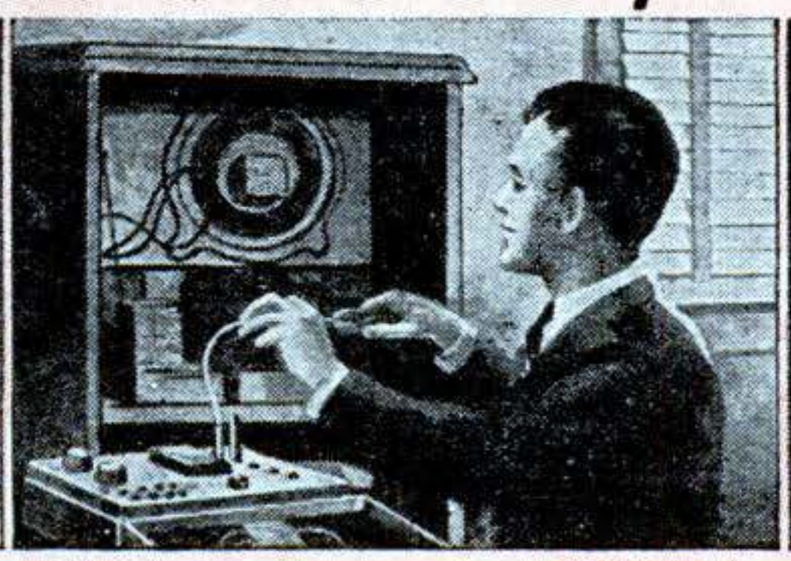

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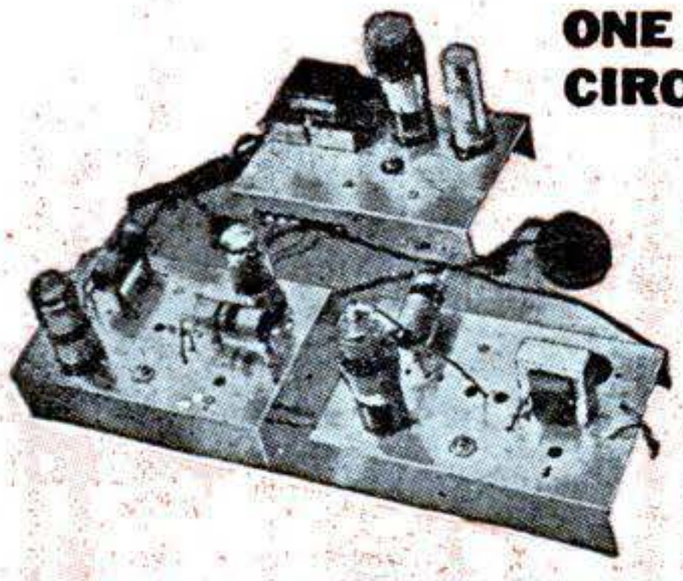

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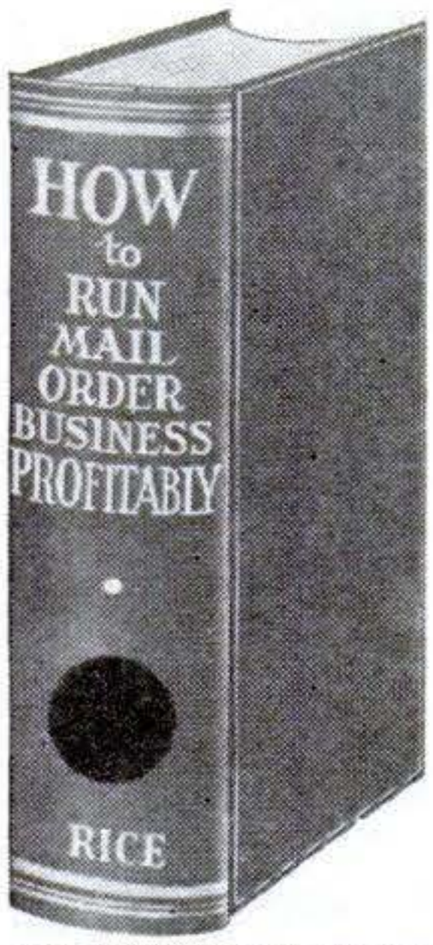

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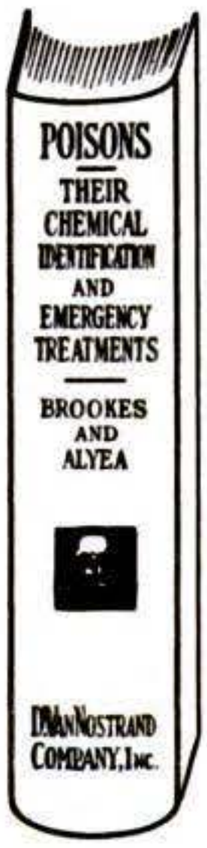

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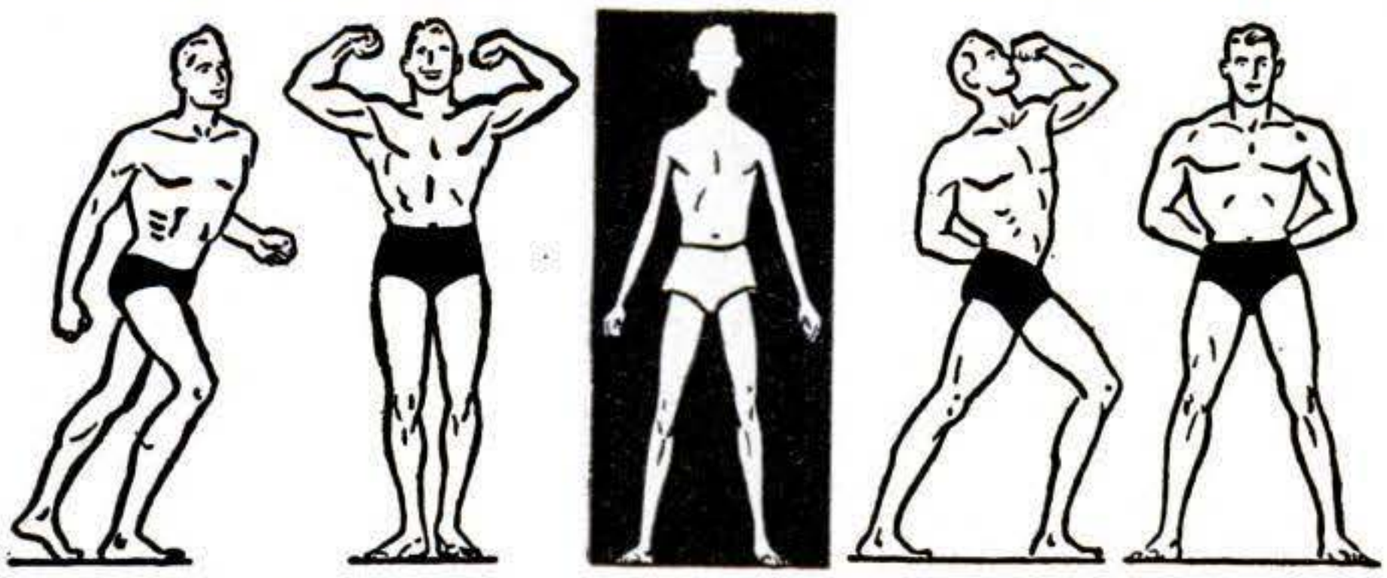

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LETTERS

Scientists, Unite!

Sir:

Science . . . is being restricted by politicians and militarists throughout the world. Before the . . . war science was international. However, scientists today are not allowed to transmit certain basic scientific information out of their respective nations because of the claimed dangers to national security.

Since unrestricted international exchange of scientific information is essential to human progress, I see no reason why the scientists of the world should not attempt to get together and form an International Science Commission, responsible only to the U. N. This commission would be composed of leading scientists from all nations, and it should have access to all scientific data in the world. The purpose of the commission would be to obtain and disseminate scientific data among nations freely. In case of a threat of war, or actual warfare, the commission would cut off scientific information of military importance to any nation deemed to be aggressive by the U. N., or to any nations already at war with each other.

CPL. JOS. GAYSOWSKI, JR.
Camp Forrest, Tenn.

Dr. Harlow Shapley, director of the Harvard College Observatory, is one scientist who agrees. He recently called on the United Nations Educational, Scientific and Cultural Organization to establish international centers for scientific studies—large-scale laboratories for astronomy, health, food, marine biology, and nuclear energy.

Scientists Vote Thanks

Sir:

I read to the members (PSM's) excellent article on the application of atomic energy to medicine (May '46, p. 91) by Carl Dreher . . . We find ourselves in perfect agreement with the statements you make in your editorial (same issue) and we are very appreciative of the . . . attitude your periodical displays toward science and scientists.

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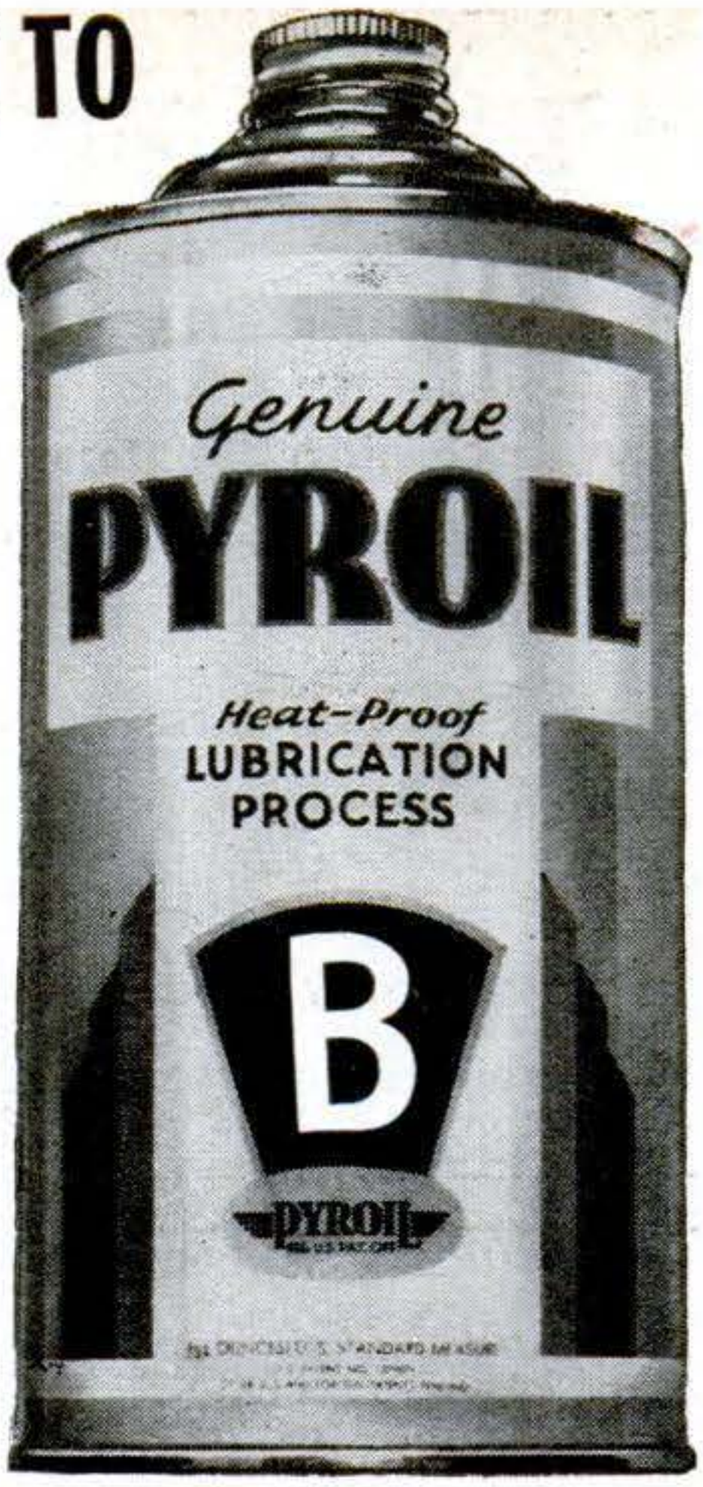

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MILTON SANDERS
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Engine Trouble

Sir:

In all the 11 years that I have been taking PSM I have noticed for the first time . . . that you have made the mistake of calling an engine a motor.

. . . An engine is a machine that develops its own power while a motor draws its power from some other source.

MARVIN C. RAMSEY
Kerby, Ore.

Webster seems less certain, defining engine as "any machine by which physical power is applied to produce a physical effect;" motor as "any internal combustion engine," or, in electricity, as "a rotating machine, as a dynamo, which transforms electrical energy into mechanical energy."

Cheers

Sir:

Hats off to that guy down there at PSM who thought of stopping the practice of running stories over to the back of the magazine. I just hated to be reading along in a good part of a story, and then see the words "continued on page 200" flash in front of my eyes. . . .

A. STRATTAN MCALLISTER, JR.
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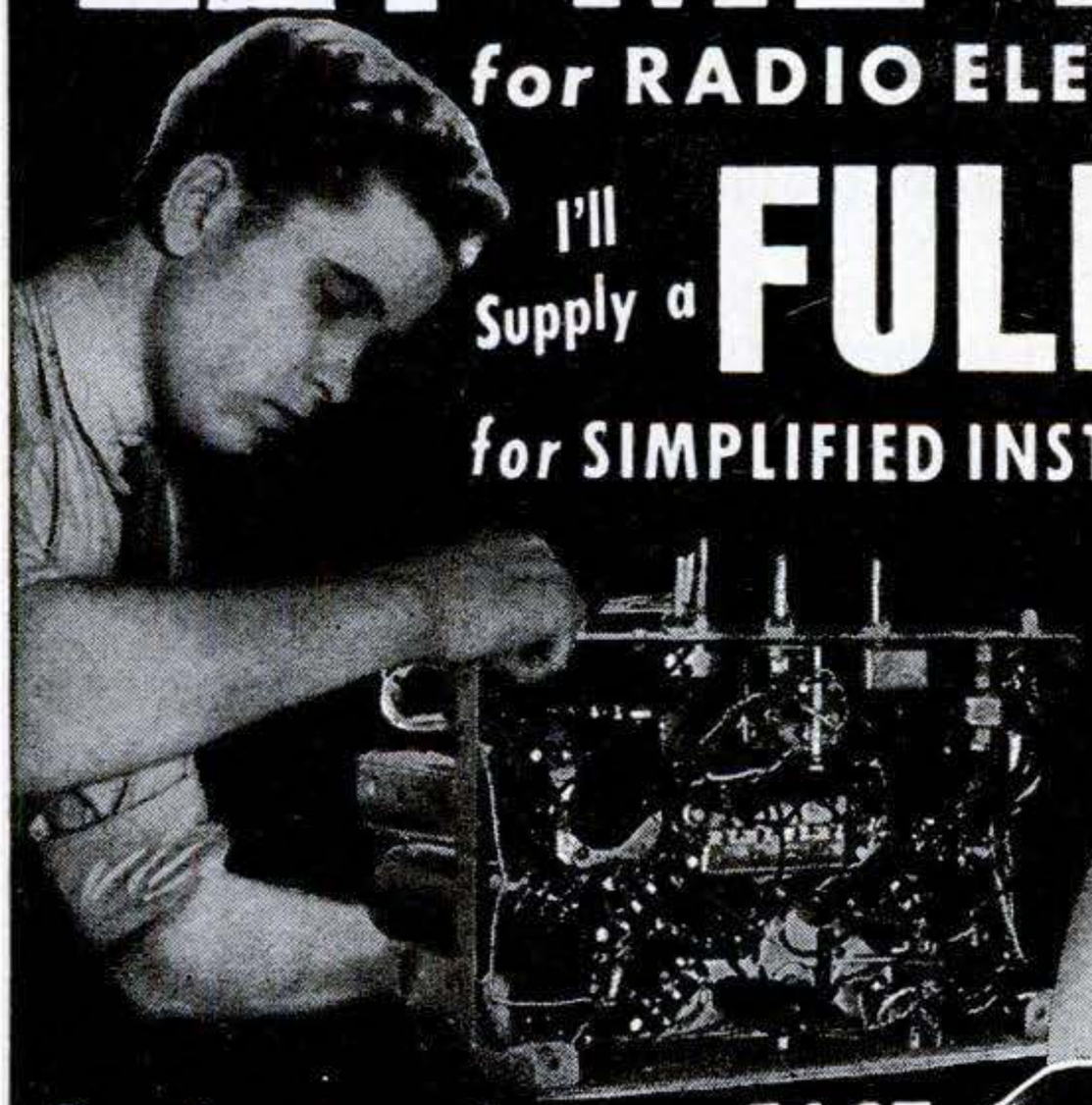

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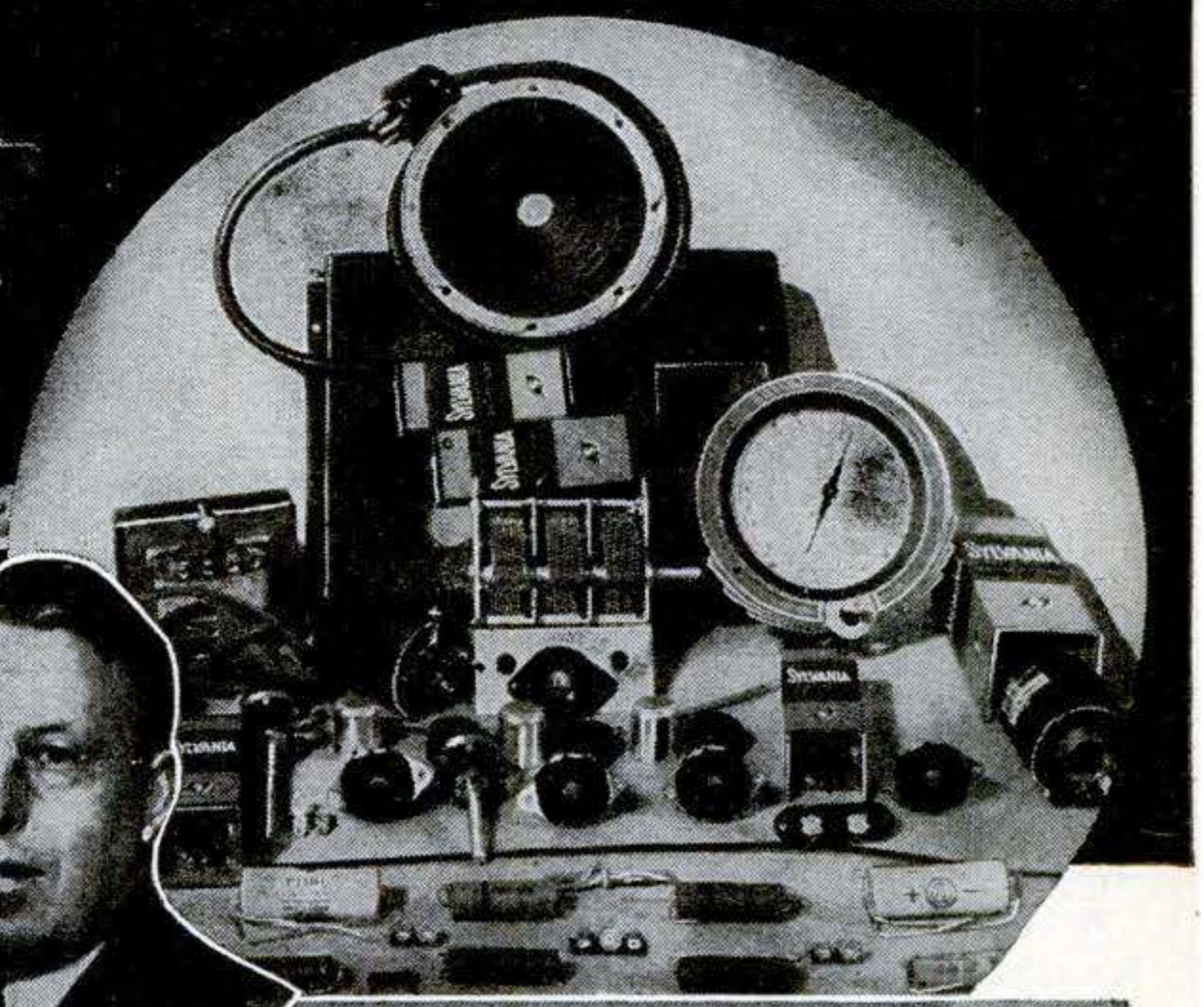

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m.p.h. The motor is so quiet that, stopped for a traffic light, you have to look at the ammeter to tell if it is running.

The only repairs it has ever had, other than expendables such as radiator hose, spark plugs and the like, is one new clutch plate and a new exhaust pipe and muffler. The finish is like new; the engine has never been taken down or touched in any way beyond a few valve-grind jobs.

It has four-wheel brakes, and complete pressure lubrication; the cylinders are mirror smooth; at 40 m.p.h. I get 13 to 14 miles per gallon of gasoline; oil consumption is less than one quart per 1,000 miles.

While I admit that such gadgets as radar-operated ash trays are missing, my Rolls still is, in spite of its age, far ahead of any modern car in sheer excellence of design with a view to . . . long life.

JOHN STANLEY

Kingston, Ontario, Canada.

Too Much Car for the Fuel

Sir:

After reading your article, "Superfuels Waiting for Tomorrow's Cars" (PSM, June '46, p. 124), I became determined to pass on to you my gripe . . . I was astonished to learn that fuel efficiency rose approximately 30 percent from 1931 to 1940. But this does not mean that fuel economy has increased . . . Friends report that it actually costs about the same or more to run one of the new cars as it did to run a car 10 or 12 years ago. If a Model A Ford could get 20 miles per gallon, then it seems logical that a 1946 Ford should get 130 percent of 20, or 26 miles per gallon. I believe it actually gets from 16 to 18.

. . . Today's car is too heavy. Power is being wasted in lugging dead weight . . . I believe the ideal car should weigh less than 2,500 pounds, should have an engine of less than 60 hp. and should have four or five cylinders to facilitate rehauling. Such a car should get better than 20 miles per gallon.

RICHARD N. KING, JR.

Providence, R. I.

PSM grants that there is no good reason why the automobile that takes a salesman on his rounds or a businessman to the station should weigh 10 or 15 times as much as its lone passenger. And some manufacturers are tackling the problem.

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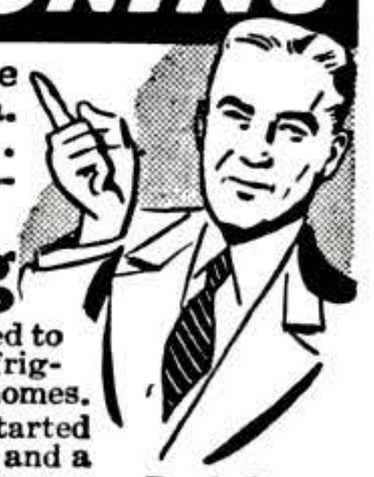

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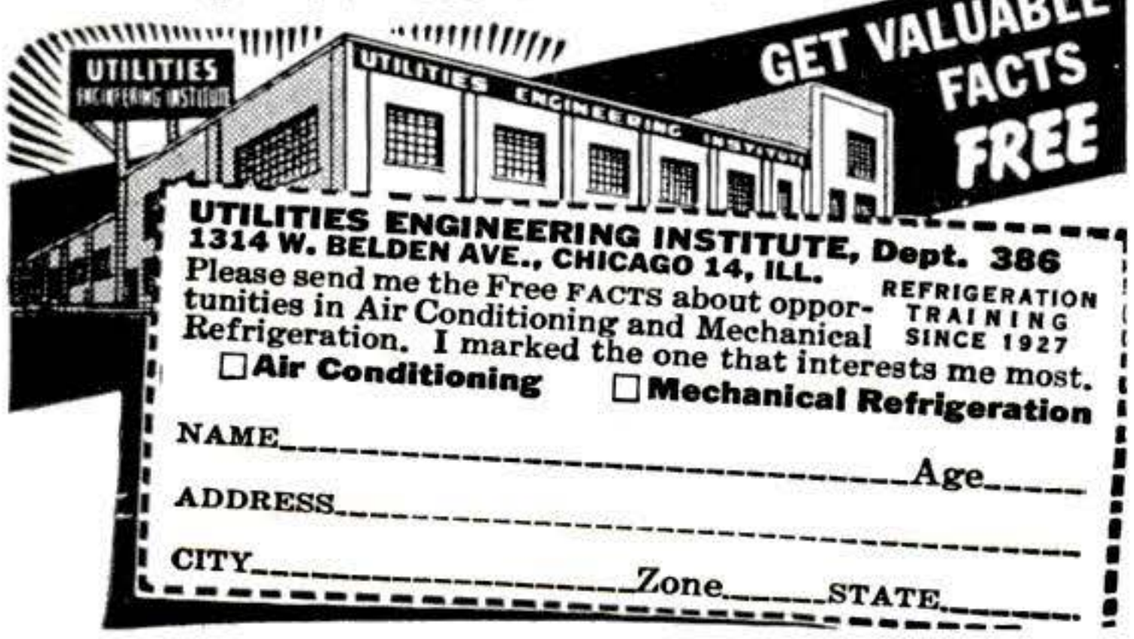

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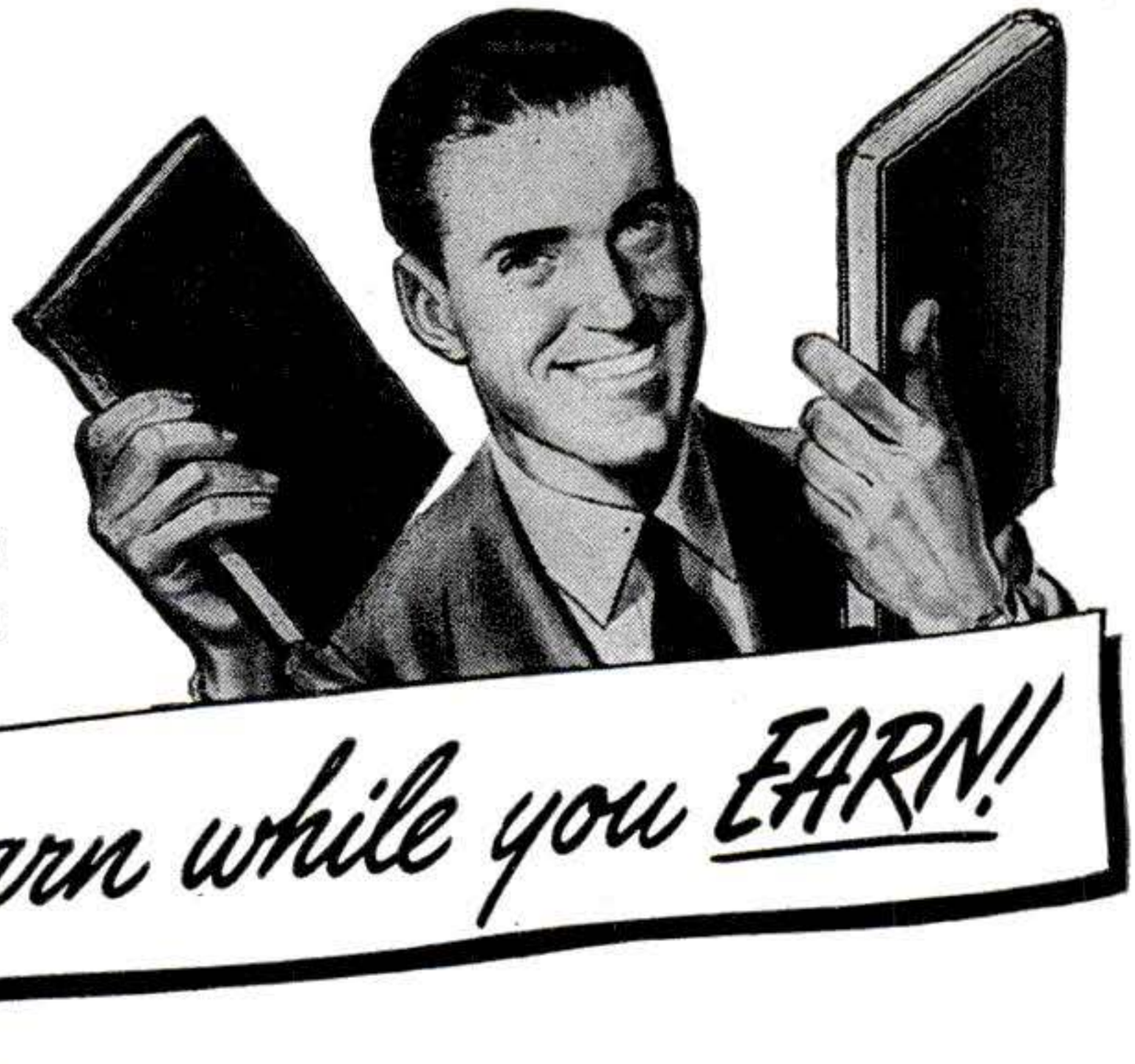

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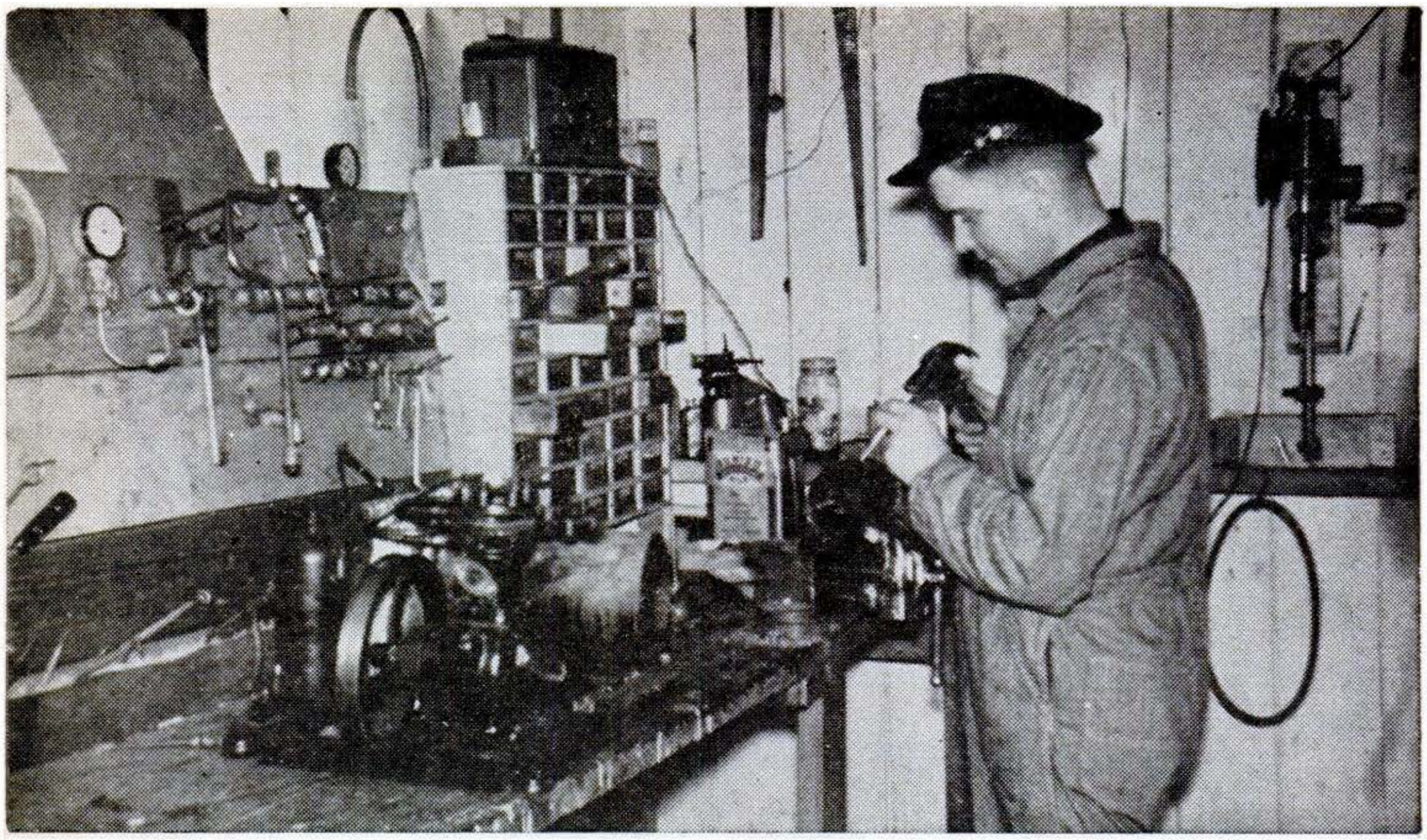

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By S. T. CHRISTENSEN

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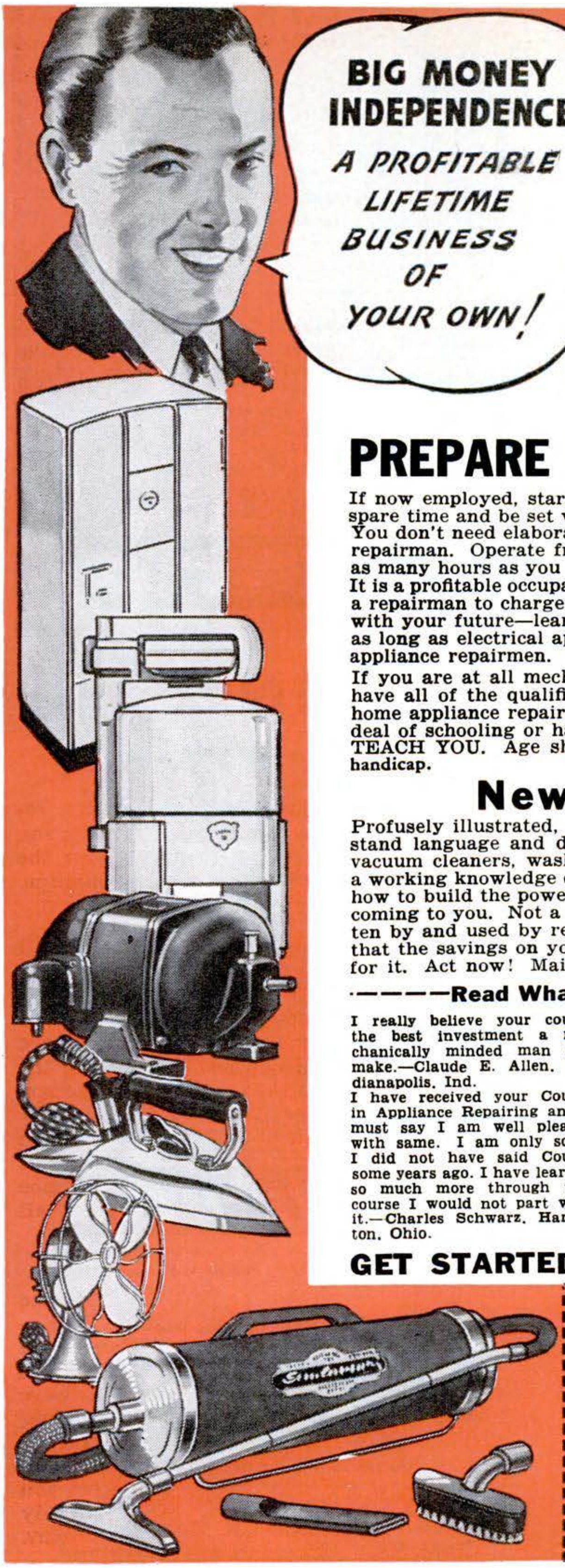

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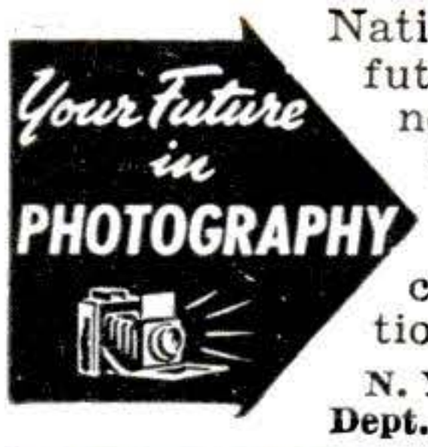

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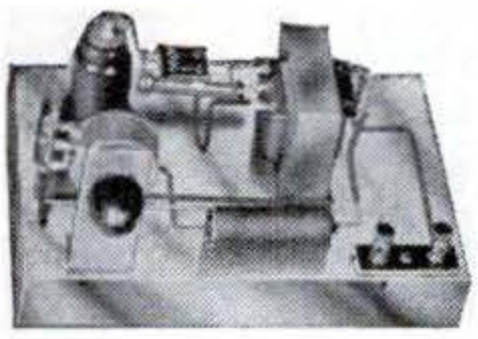

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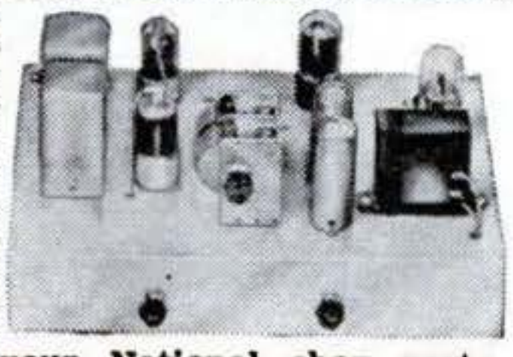

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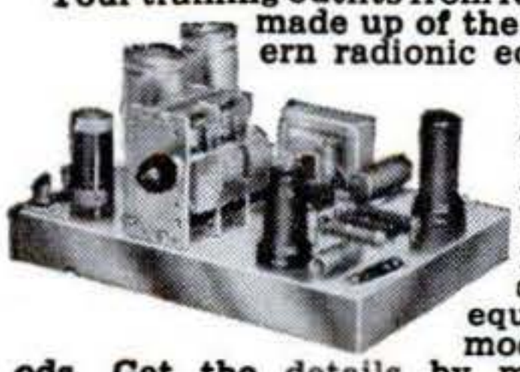

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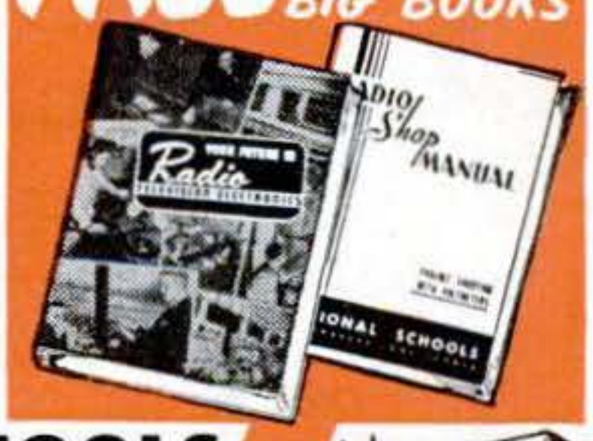

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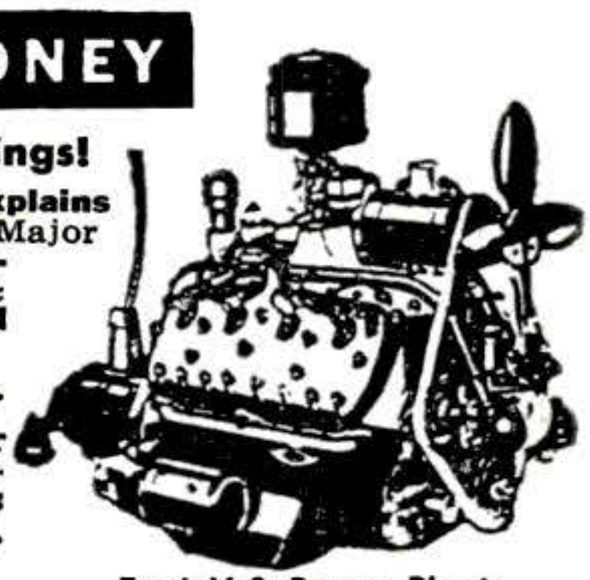

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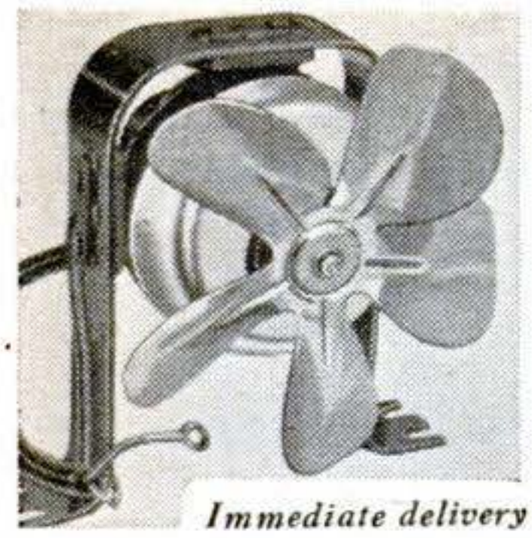

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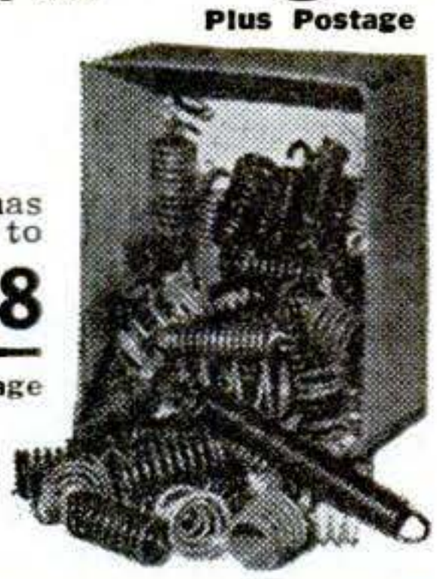

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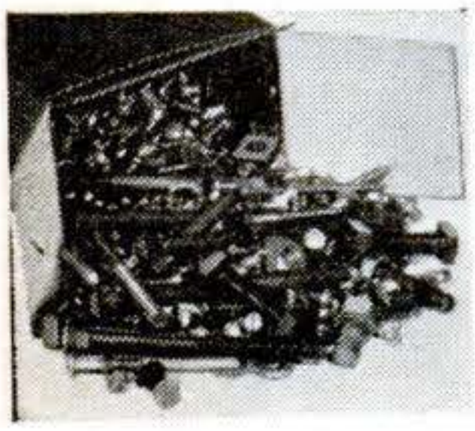

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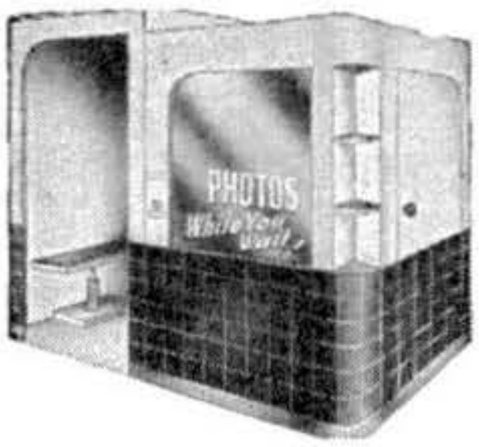

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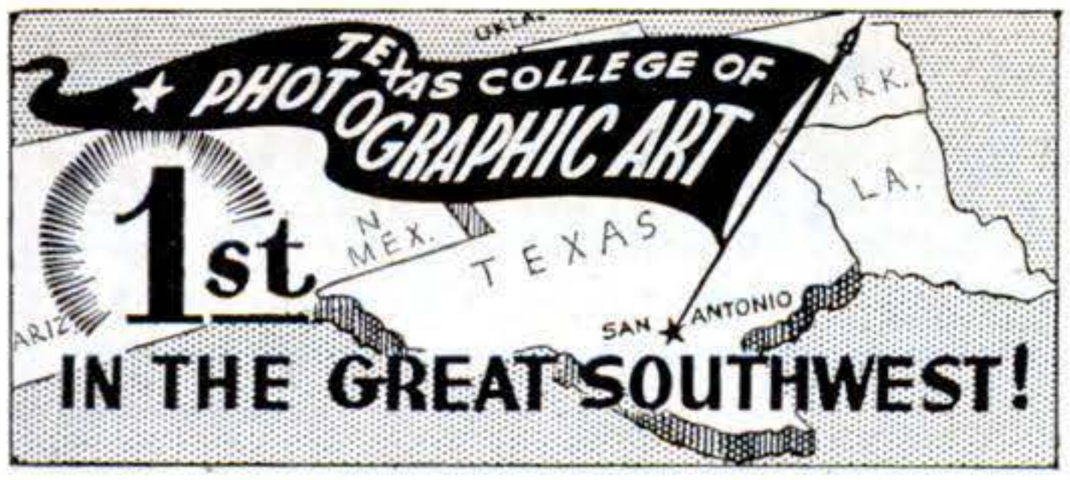

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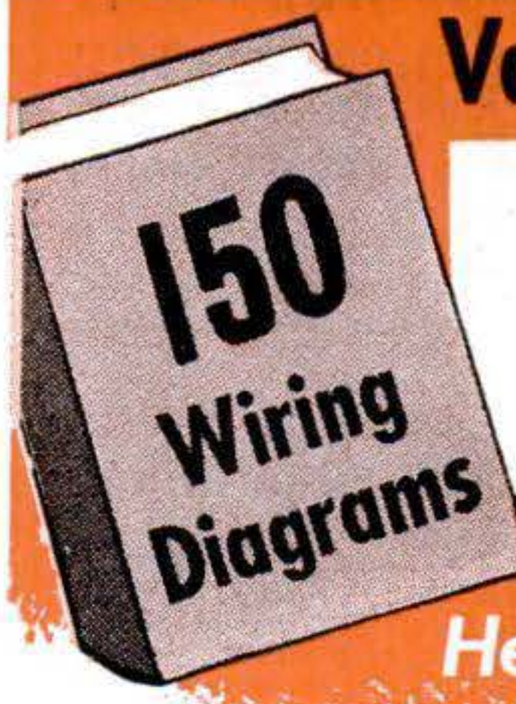

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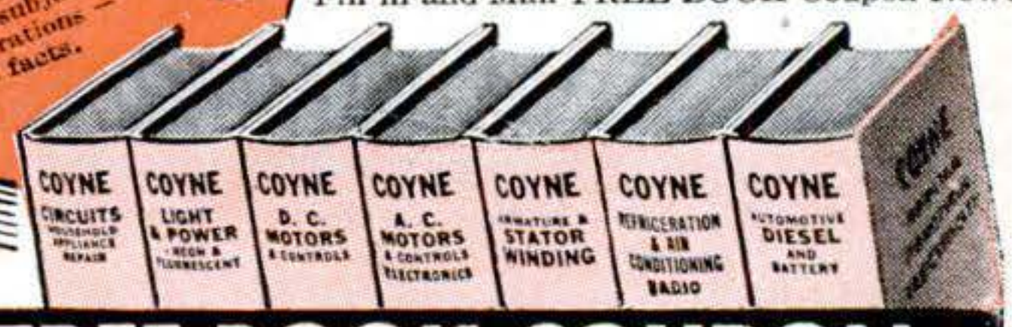

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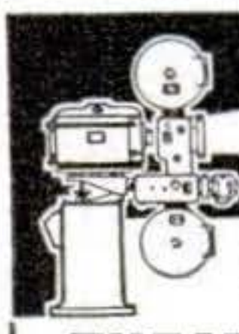

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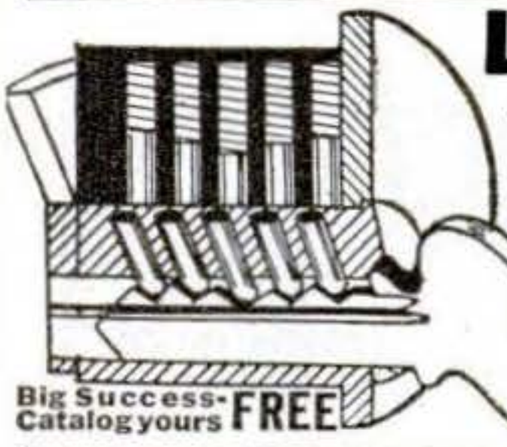

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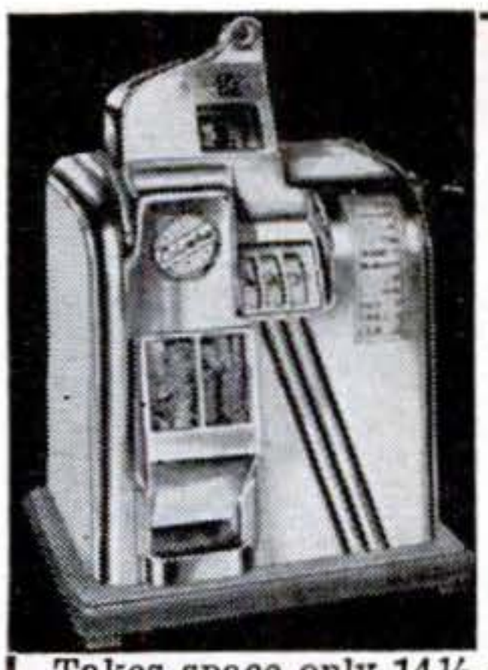

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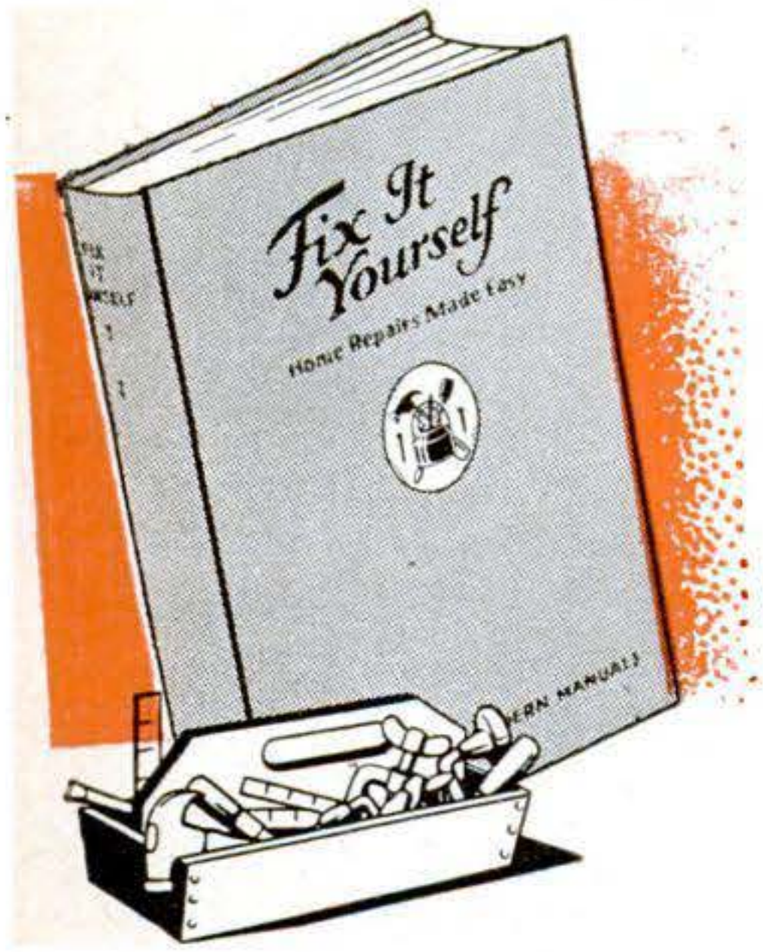

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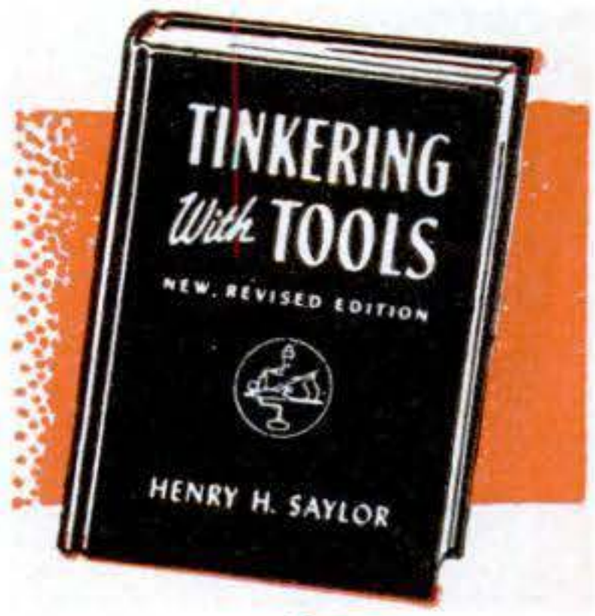

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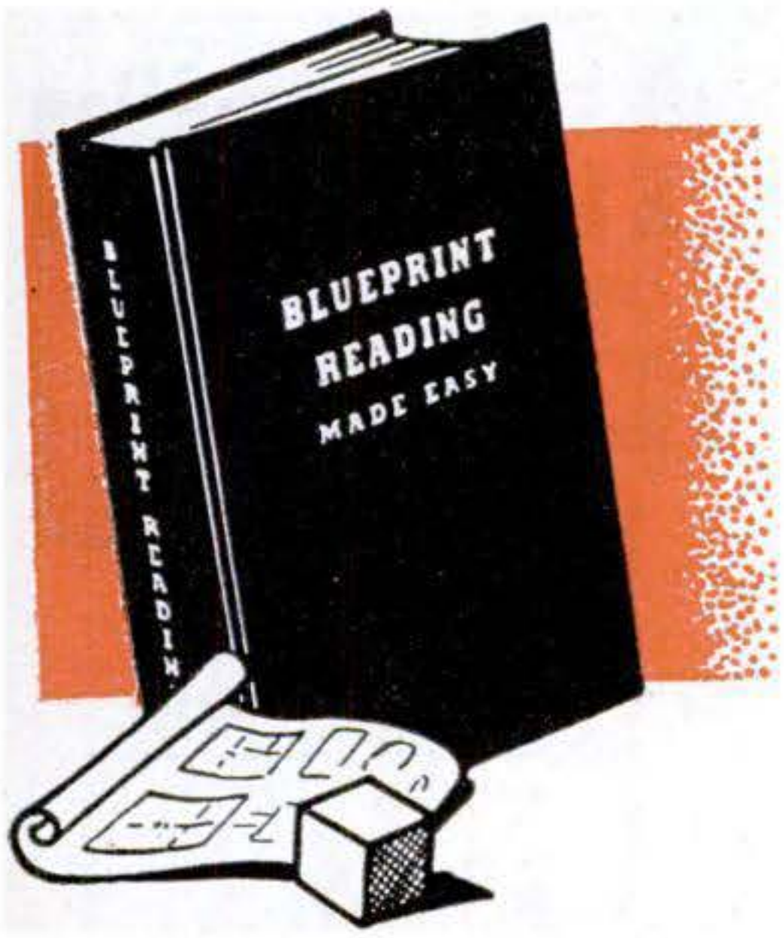

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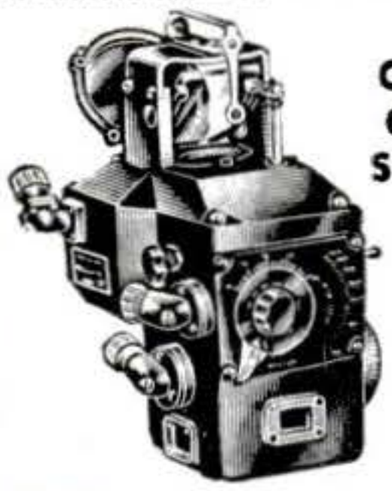

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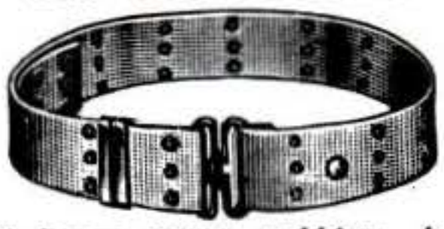

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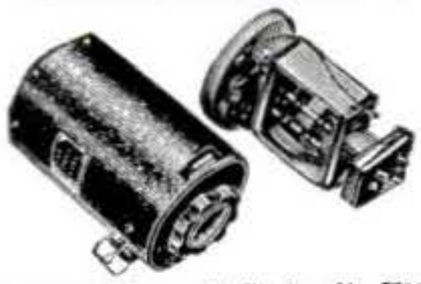

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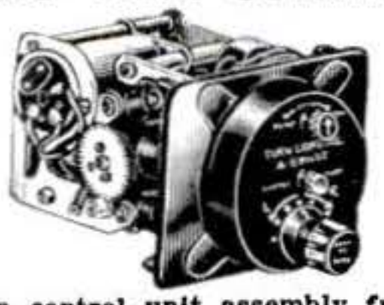

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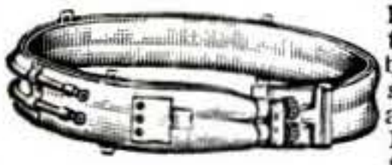

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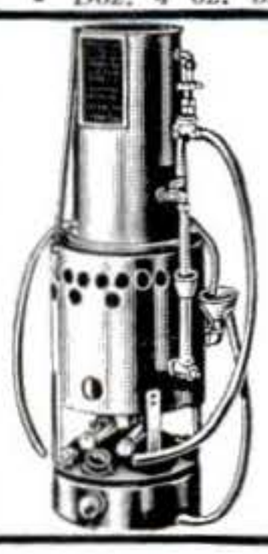

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SILVER Plating Liquid: (Improved Formula). You can see it silverplate instantly right before your eyes. Simply rub-on with a cloth . . . or . . . immerse articles in the Liquid and see them silverplated. Remove and rub-up and they are done. About 1 minute. Renews silverplated ware like new. Cleans, silverplates, polishes, (3-results) from one application. Silverplates before your eyes onto sterlingware, plated silverware, also onto articles of brass, copper, bronze, zinc, nickel-silver, german-silver and all affinitive metals. Puts on genuine 1000 Fine silverplate. Guaranteed lasting finish. Won't rub off boil off or brush off. Has many adaptable uses throughout the automotive, refrigeration, radio, jewelry, research and experimentation, musical instrument, surgical and dental instrument, beauty shop equipment, antiques, art goods, hobbies, hardware, and many other lines. Working sales-distributors needed for many areas not being worked now. Details by letter mailed free. NuProcess Products Laboratories, Dept. 239, Aurora, Ill.

FLASHO amazing powder cleaner for cars makes hard job easy. Sample free. Be our agent. Langdon, 4614 Prospect, Cleveland 3, Ohio.

EASY money now to Christmas. Up to 100% profit selling friends, others marvelous new 1946 Christmas and year 'round box assortments—30 boxes 35c up. Odd cards 2½c up. Extra bonus. Request special feature $1.00 Christmas assortment on approval. Send today for free samples of our fast selling 50 for $1.00, 25 for $1.00 personal Christmas cards and personal stationery lines. Special offers. New England Art Publishers, North Abinton, Mass.

UP to 100% profit selling friends outstanding $1.00 Christmas card assortment. Costs you 50c up per box. Also Religious, Gift Wrapping, Birthday assortments 35c up. Extra Bonus. Request sample $1.00 Christmas box on approval. Free sample 50 for $1.00. 25 for $1.00 personal Christmas card and stationery portfolios. Special Offers. Elmira Greeting Card Co., M-150 Elmira, N. Y.

NEW, extra money plan. Up to 100% profit showing friends unusual Personal Christmas cards, Box assortments, Gift Wrappings, Humorous, All Occasion, Birthdays, Social Notes Personalized Stationery. Extra bonus. Request Free 50 for $1, 25 for $1, 25 for $1.95 name imprinted Christmas Cards and personalized Stationery folder. Special Offer. Thomas Terry Studios, 256 Union Ave., Westfield, Mass.

WE pay you $25 for selling fifty $1.00 boxes. Think of it! 50 beautiful assorted Christmas cards sell for only $1.00, your profit 50c. Write today for free samples. It costs nothing to try. Cheerful Card Co., Dept. 225, White Plains, New York.

CHRISTMAS Cards. Earn $5.00 with every ten $1.00 21-in card assortments you sell. Also wrappings and 25 for $1.00 imprinted cards. Write for samples today. Howard P. Ellis, Dept. PS-8, Pitman, N. J.

$3 FIRE Extinguisher sells wholesale or direct. "Fire Killer", Zone 1, Syracuse, New York.

HARMONICAS, $10.80, $19.80 dozen. Harmonica Wholesalers, 11 E. Centre Street, Baltimore 2, Md.

"OUR Flag"—famous picture. Four colors. 500,000 sold. Sample print——Free. Our Flag Sales Corp., Dept. C-1065, Excelsior Springs, Mo.

CHRISTMAS Cards. Earn Big Money. Take orders galore from friends. 25 exquisite folders with name $1.25. Free samples 10 designs. America's Fastest Selling 21 Christmas Folder box. Costs 50c. Sells $1. Request samples today. Sunshine Art, Dept. N, 115 Fulton St., New York City.

WOULD you pay 3%—first $350 made? Color-illustrated book "505 Odd Successful Enterprises" free! Proven! Work at home, office. Expect something odd! Pacific, 262-E Drake, New Rochelle, N. Y.

HAVE Car? Extra money doing nothing. Write J. Ragno, Berwick, Pa.

POWER Mower—Cuts—Trims. Agents-Dealers. Farm Products, M-2017, Excelsior Springs, Mo.

CLEAR-VU on windshields, eyeglasses, mirrors stops fogging. Gives sparkling clear vision in fog, mist, rain, steam. Agents send 50c for introductory offer. Currier's Distributing Co., 2602 Boston, San Diego 2, Calif.

SELL through agents? Your ad in this column will reach capable, ambitious men who are interested in making more money. They may be interested in your proposition. Advertise it here and get business. Rate is only 50c a word. Write for details to O. K. Kelly, Classified Section, 353 Fourth Ave., N. Y. C.

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SCHOOL Seniors! A Postal Will Bring You Our Kwick-Sell Cardalog of graduation name cards. Hot selling everywhere! Big profits! Hurry! Craftcards, Box 235(M), Pittsburgh 30, Pa.

6 AIR CONDITIONING & HEATING

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7 AMERICAN POLICE JIU JITSU

DEADLY Judo—Fiercest fighting technique. Trick knockouts. (200 photographs plus illustrations.) Expert instructions. Three volumes. Complete $2.25. Variety House, Box 46-AH Wall Station, N. Y. C. 5.

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9 ASTROLOGY

MENTAL Science Course. Revealing. Helpful. Booklet free. Write Clark, 125A West 7th Avenue, Cheyenne, Wyoming.

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11 ARCH SUPPORTS

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12 AUTOMOBILES

RACING car fuel concentrate supercharges gasoline for all cars. More power, speed $1.00 pint. Free speed equipment literature. Lee Motorcraft, 1412-B Great Northern Bldg., Chicago 4, Ill.

AUTOMOBILE Racing Book. Fifth Edition —Revised. Tells how to build dirt tracks bodies, frames, engines. Records, superchargers, rules, formula, plans, stock conversions, roadster racing, fast Fords. $1.00 postpaid; $1.15 C.O.D. Ray Kuns Department 274, Madisonville, Cincinnati, Ohio.

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"500 MILE" Indianapolis Automobile Racing History Book, just printed. Complete history detailed year by year results every Indianapolis race since 1909. 320 large pages, over 2,000 illustrations, drawings, photographs describe foreign, American racing automobiles. Photographs world's famous drivers. View in your arm chair every mile of every event at 10c a race average cost. Complete book Postpaid $3.50 De Luxe Edition bound attractive red Du Pont Fabrikoid $5.00. Limited number available hurry! Clymer, Dept. B82, 2125 W. Pico, Los Angeles 6, Calif.

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14 AUTO TRAILERS

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18 BLUEPRINTS AND PLANS

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TYPEWRITER Repairing—Original Course —Simplified Home Study. Weber Typewriter Mechanics School, Box 269, Osborn, Ohio.

MANUFACTURE Costume Jewelry At Home For Profit, Hobby, Theraphy. Free Wholesale Supply Catalogue. Instructions. Florida Supply House, Bradenton, Fla.

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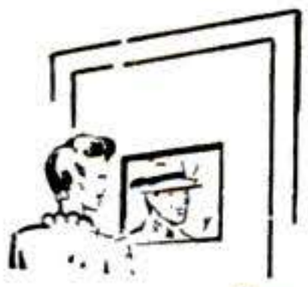

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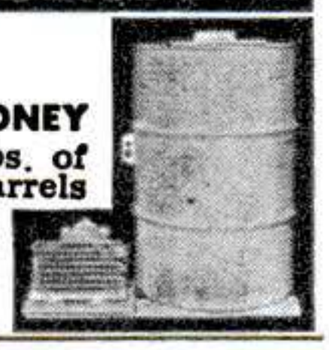

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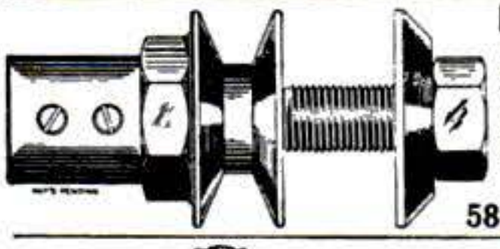

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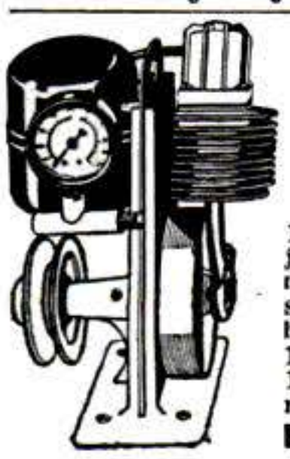

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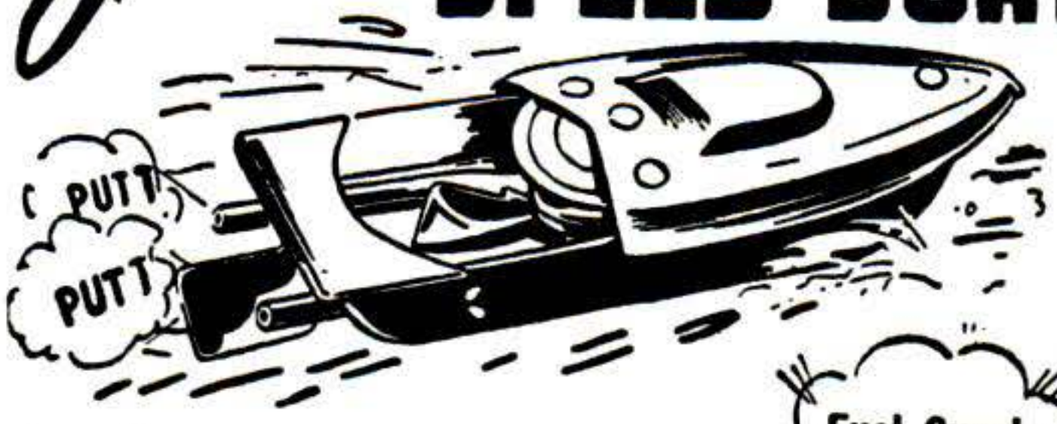

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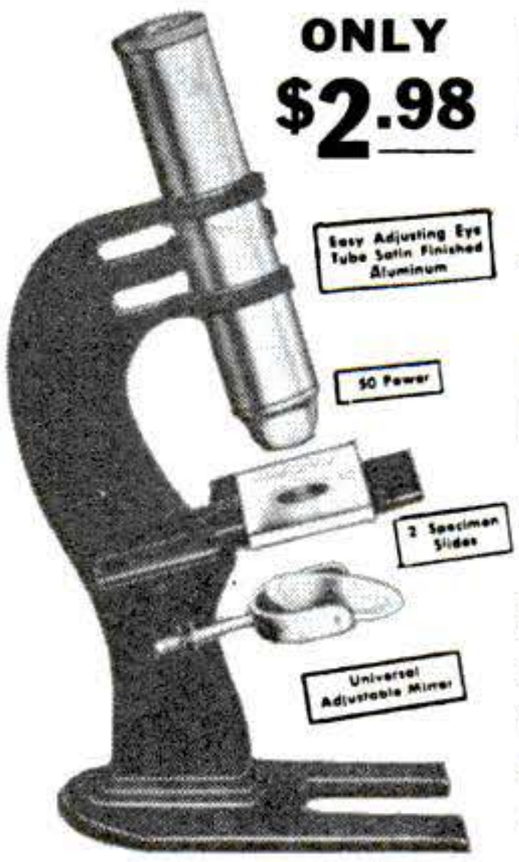

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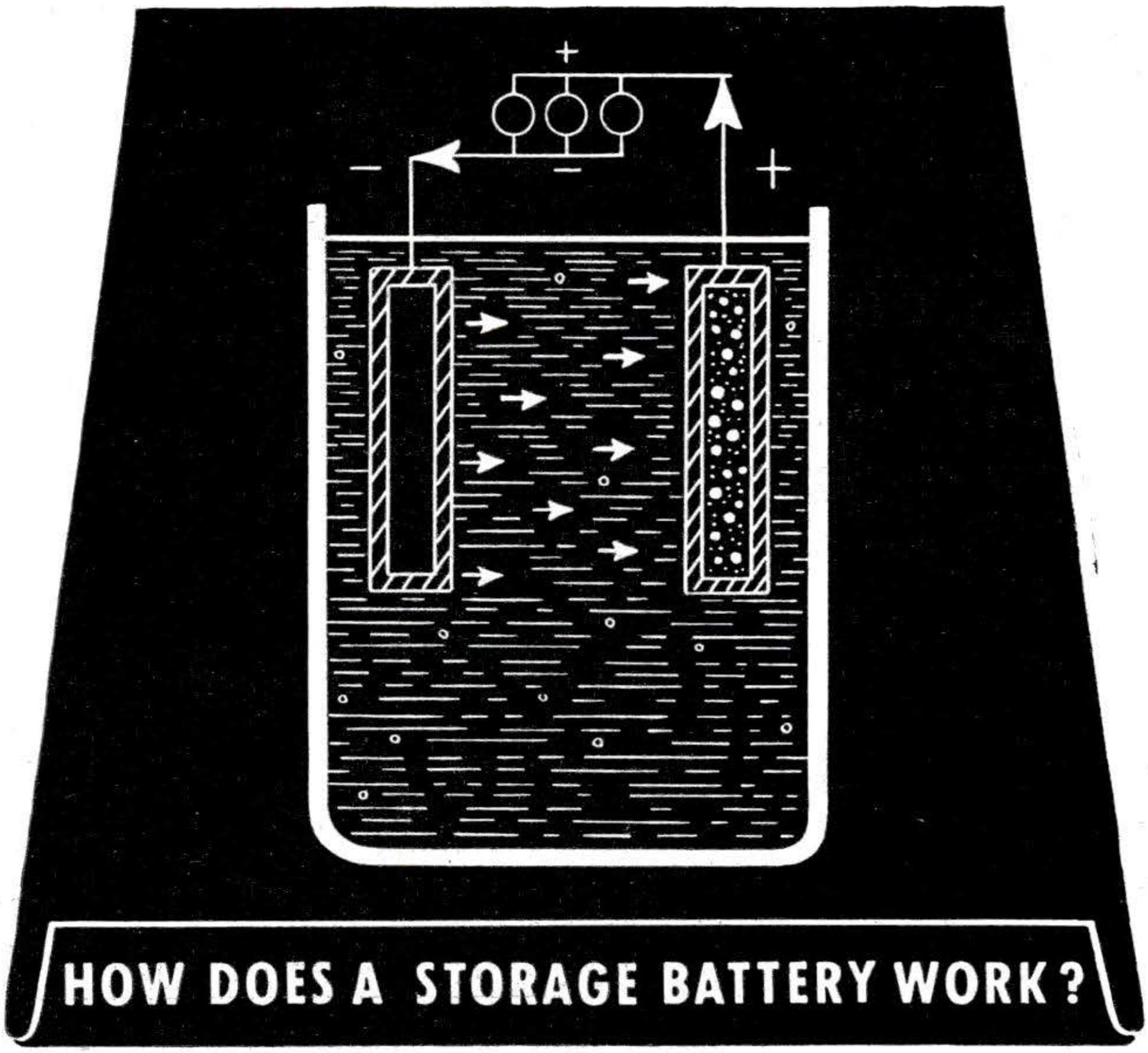

A storage battery is a reservoir for storing energy. Energy enters the battery as electricity, is stored as chemical energy and delivered as electric current. The principle is very simple.

Plates of two different metals (lead peroxide and sponge lead) are placed in a solution of sulphuric acid and water.

The acid attacks the metals chemically, exerting electric pressure (voltage) between them.

When wires from the two metals are connected outside the solution, current will flow.

Though alike in principle, storage batteries differ in capacity—the number of ampere hours delivered continuously for a definite time.

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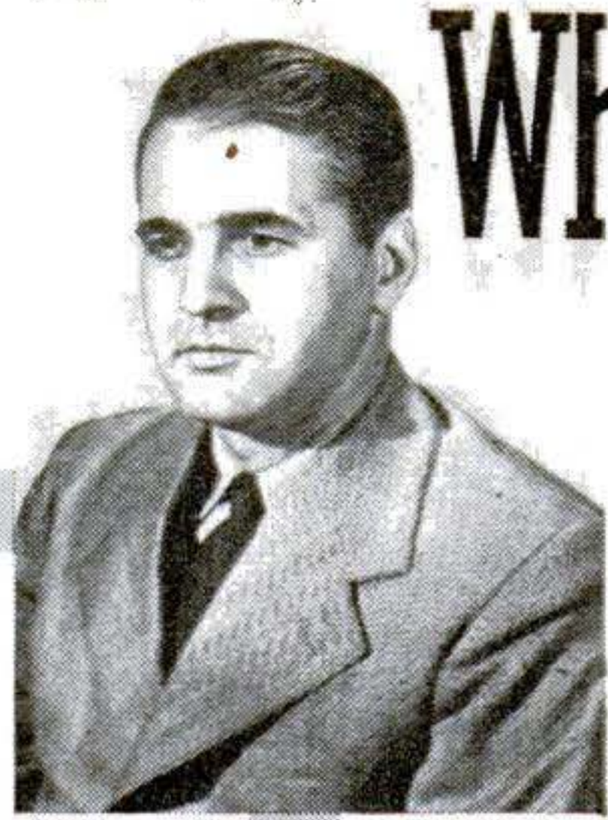
POPULAR SCIENCE MONTHLY
AUG. 1946

HERCULES HEADS FOR THE SEA . . . The 220-foot hull of the largest airplane in the world, Howard Hughes's eight-engine Hercules, moves majestically on dollies toward Terminal Island, Calif., for assembly. The spectacular moving job (see page 94) began when the two 34-ton wing sections, each 160 feet long, preceded the fuselage on the 28-mile journey from Culver City. First test flight of the flying boat is expected early next year.

What to Look for



A FORMER Rhodes Scholar, Nieman Fellow, and Atlantic Prize Essay winner, Robert Lasch became interested in America's housing problems when he built his own house in Omaha, where for 10 years he was on the editorial staff of the World-Herald. *Lasch, now an editorial writer and columnist on the* Chicago Sun, *is the author of "Breaking the Building Blockade," which discusses at length the problems the country faces in building 12,000,000 homes despite shortages of materials and skilled labor, and an antiquated building system.*

By ROBERT LASCH

THE day is at hand when the American family can go shopping for a house just as it shops for a car or a refrigerator. Prefabrication, after 15 years of false starts and experiment, is about to come into its own.

National Housing Expediter Wilson Wyatt has fixed production goals that will bring houses out of factories during the next two years in greater volume than hammer-and-saw methods built in all but boom years.

Even if the former mayor of Louisville stubs his toe, as the old-line construction industry hopes, we shall undoubtedly see a boom in prefabs this year and next. With or without government wet-nursing, an infant industry is going to grow up in a hurry.

What will these factory-built homes be like? First of all, they are going to be small. High costs combined with veterans' price ceilings will put most of the prefabs you see during the next few months in the Austin or Jeep class. When the day comes that houses are rated in square feet as cars are rated in horsepower, these GI prefabs will be known as 750-square-footers or less. That is no smaller than the conventional cottage, but it is not exactly spacious living.

Except for costs, there is no inherent reason why prefabs must be small. Whatever sacrifices they make in space, most manufacturers, as they sweat for materials and scramble for dealer outlets, are firmly resolved that their product shall look as much like any other house as possible.

In its early days, prefabrication tended to go hand in hand with contemporary design—the flat roof, the boxlike structure, the ruthlessly functional plan. This may be the style of the future, but public taste in the mass market responds more heartily to the unsophisticated appeal of Cape Cod and Midwest Colonial.

Since prefab must, above all, shoot at the mass market—at the great middle group of incomes between $1,800 and $4,500 a year—most of its practitioners have dedicated themselves to pitched roofs, fake shutters, window boxes and similar earmarks of the cozy cottage that the word "home" evokes in so many imaginations.

Variations on the Prefab Theme

What sets the prefab house apart from its forebears is the way it is built. As the term connotes, prefabrication means moving home construction from the site, where it traditionally proceeds nail by nail and timber by timber, to a central factory. There are several variations on this theme.

Some prefabs are constructed entirely in the factory, and moved in one piece to the owner's lot by truck. Owing to the limitations imposed by the standard highway, the basic unit of these models cannot be more than eight feet wide, and so bears a close

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in Prefabs

12 QUESTIONS TO ASK YOURSELF BEFORE YOU BUY

1 . . . Are you within delivery range of a prefabricator (300 miles is the limit for most)?

2 . . . Do the materials and structure meet FHA requirements and Commercial Standard CS125-45*?

3 . . . What is the heat-loss rating of the insulation and heating system?

4 . . . Have standards of the National Board of Fire Underwriters been observed throughout?

5 . . . Have adequate steps been taken to guard against moisture seepage and condensation?

6 . . . If exterior plywood is used, how weatherproof is it?

7 . . . Is the structure heavy enough to withstand normal snow loads in northern climates?

8 . . . Does the price include plumbing; heating; kitchen sink and cabinets; wiring; painting?

9 . . . Are the connectors between panels as strong as the panels?

10 . . . Are window and door openings tightly sealed?

11 . . . Do the flues and chimneys meet standard fire-safety tests?

12 . . . Do plumbing and wiring comply with prevailing codes of the National Bureau of Standards?

relationship to the trailer—itself the most conspicuous example of the mobile house.

One widely used method represents a compromise between traditional construction and factory techniques. This consists of building large sections of the house on jig tables. Power tools, the use of standard measurement units, and quantity production enable the factory to turn out entire walls, roof sections, floors and ceilings rapidly. These are shipped to the site and erected somewhat after the manner of pioneer barn-raisings.

Purists will insist that true prefabrication is neither of these, but a method that employs standardized panels. The ultimate expression of this idea would be found in a system that used one interchangeable panel for every part of the house. But most manufacturers today offer the customer a dozen or so types, each adapted to its particular function.

In this kind of prefabrication, a wall panel, usually four feet wide, consists of a structural frame sheathed with plywood or siding outside and wallboard or plywood inside. An-

* Dept. of Commerce publication setting forth minimum requirements voluntarily accepted by members of the Prefabricated Home Manufacturers Institute.

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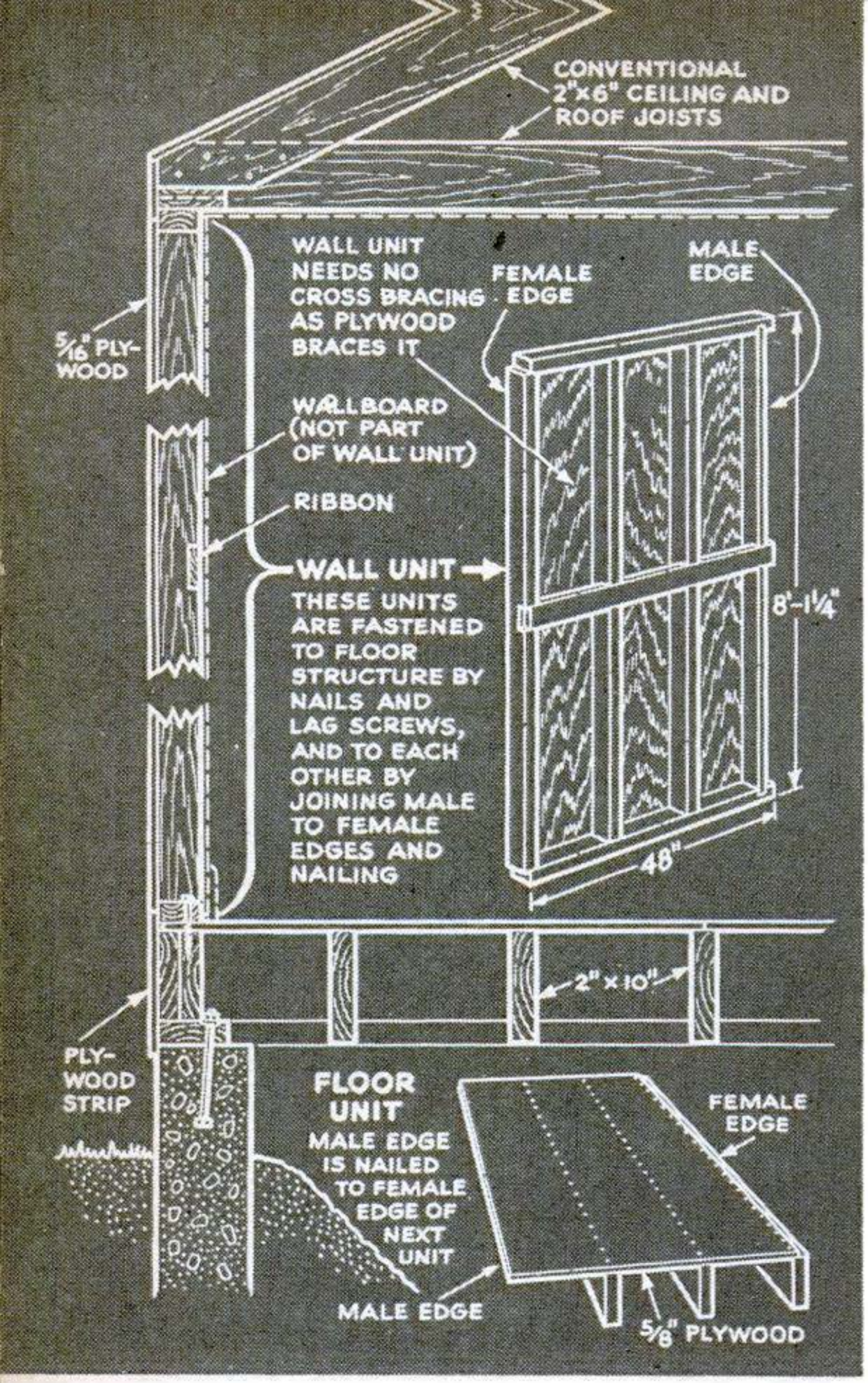
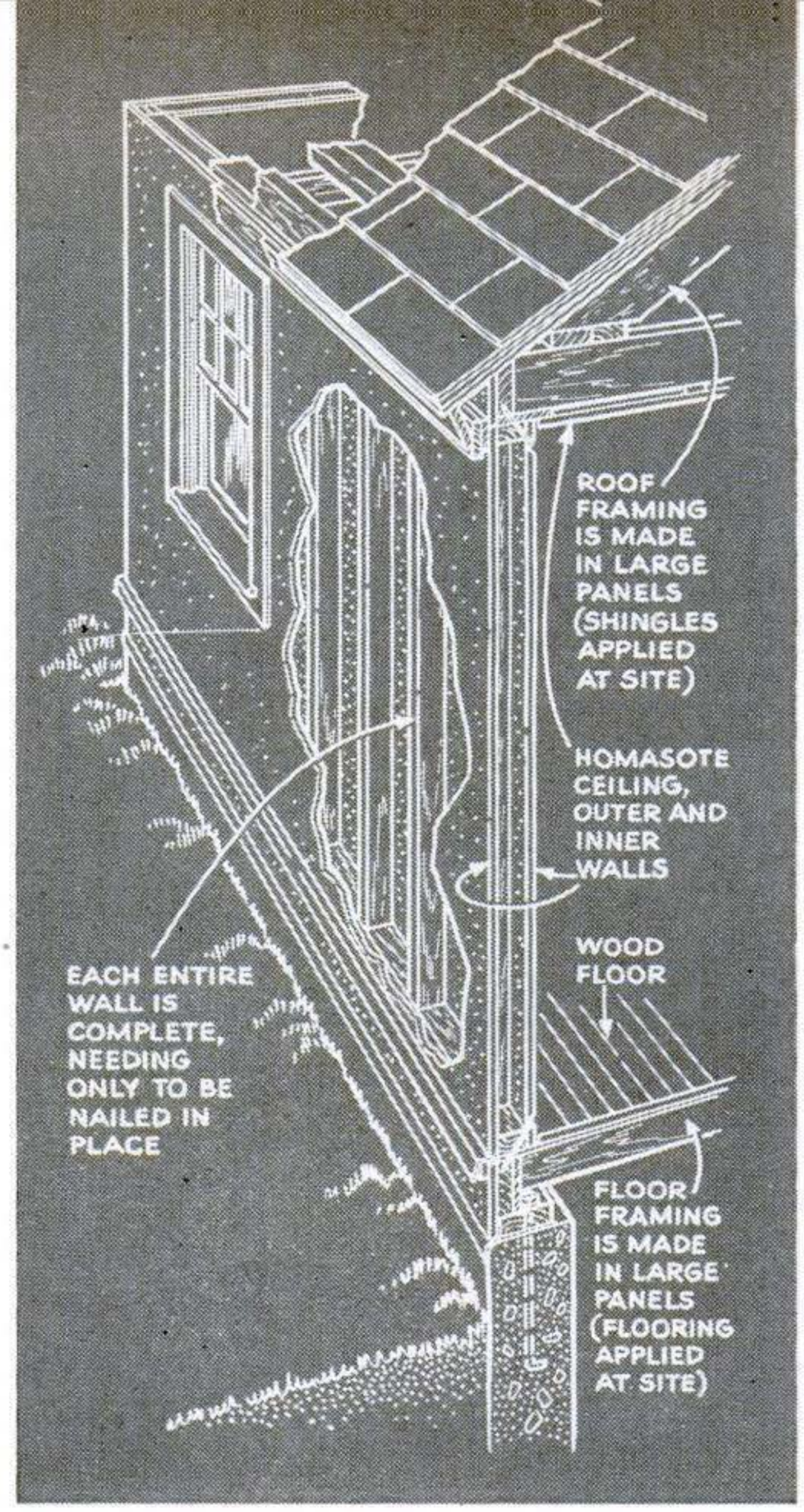


WOODEN-FRAME CONSTRUCTION, PANEL ASSEMBLY. Advanced step on old system of precut, individually numbered pieces of lumber. Regular stud-and-sheathing construction is assembled into four-foot panels at the plant, then nailed together at the site. Many companies use this technique; above details are from American Houses.



WOODEN-FRAME CONSTRUCTION, WALL ASSEMBLY. Some prefabricators assemble the parts into walls of a whole room. An entire inner wall is cut from one piece of sheet material, overcoming the difficulties of concealing the joints between panels. Large units save time and money. Above drawing is from Precision-Built plan.

other panel has the same structure with an opening punched in it for a window, which is set in place and glazed at the factory. A third contains a frame and door, and so on. Such panels are easily shipped and can be handled by two men. They are bolted to the foundation in series, and joined at the seams with splines or connectors.

Structural Soundness Proved

There is no longer any doubt of the structural soundness of prefabs. Carefully erected, they stand up in all kinds of wind and weather as well as conventional construction does. The industry has acquired ample experience to show that stressed-skin panels, in which the sheathing becomes a structural unit with the frame, are efficient and safe at thicknesses as slight as two inches. The crucial link in the chain is the connector, which joins the panels together. Many firms have solved this problem by devising joints that virtually weld one panel to another. Some prefabs have been favorably tested in 200-mile-an-hour winds.

The woods will be full of housing nostrums in the months to come. Some will work out, some will not. The wise consumer

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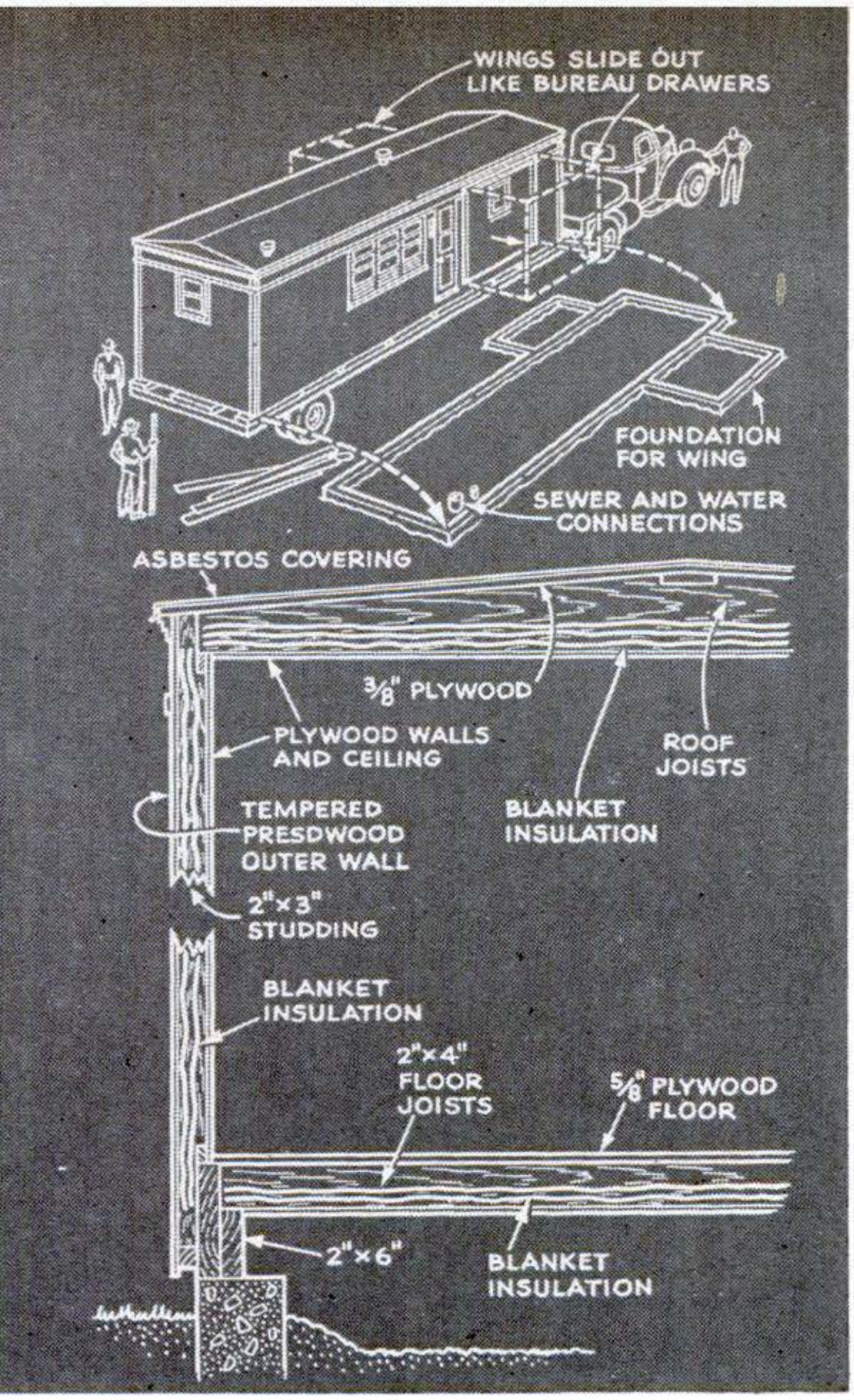

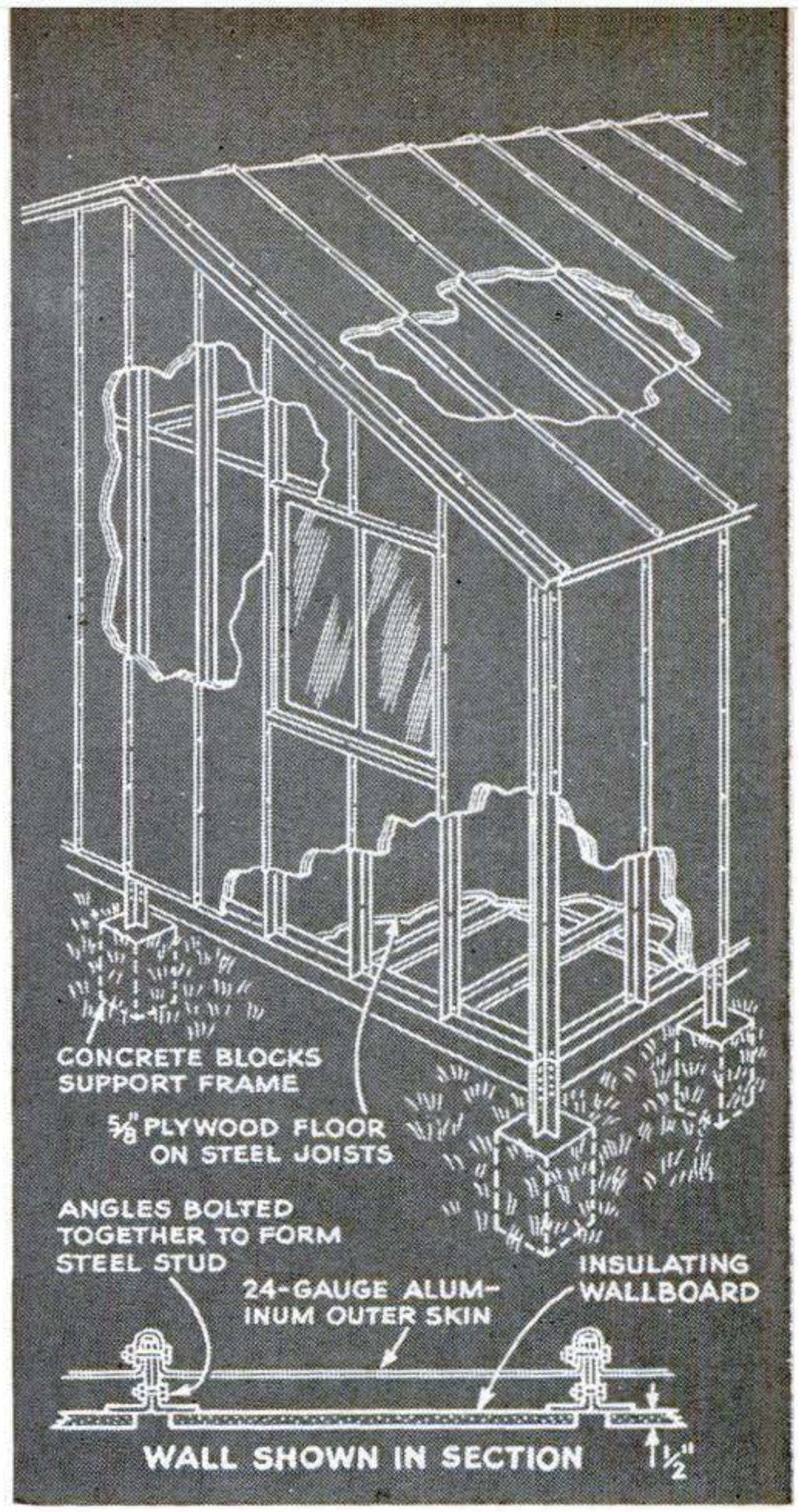

HOUSE ASSEMBLY. A timesaver is to assemble the entire house in the factory and move it to the site in one piece. But this limits a unit's width to eight feet, to fit on a delivery truck. Wingfoot Houses (details above) have two "super drawers" that are pulled out at the site, making home 15 feet wide at one end.

METAL FRAME AND SHEATHING. One form of prefabrication involves steel framing units, precut and drilled, and standardized aluminum sheets that are bolted to the frame to provide the sheathing. Rigid insulation is clipped to the frame on the inside. Units are combined to make larger houses. Details above are from Steelcraft.

will investigate closely every sensational "discovery," and be ready to accept only tested materials and proved methods.

It is too early yet to decide who is going to be the Ford, the General Motors, and the Chrysler of the industry. At the moment prefabricators are springing up in every corner of the land. Before the war, there were only a dozen substantial producers. By 1942, thanks to a war-housing program under which one-fifth of the government-built dwellings were prefabricated, the number of relatively stable firms had risen to 80. Today hundreds of producers are in the field, with more coming into the picture every day.

One leader has described the industry in its present state as more like the coat-and-suit business than automobiles. In time a great many of the smaller producers, and no doubt some of the larger ones, will be shaken out, leaving perhaps 50 or 100 experienced firms operating chains of factories over the country. Meanwhile, the house hunter with a line on his lot and contact with prefab dealers in his community will do well to put his faith in the established firm with some experience under its belt and a product that meets acceptable standards.

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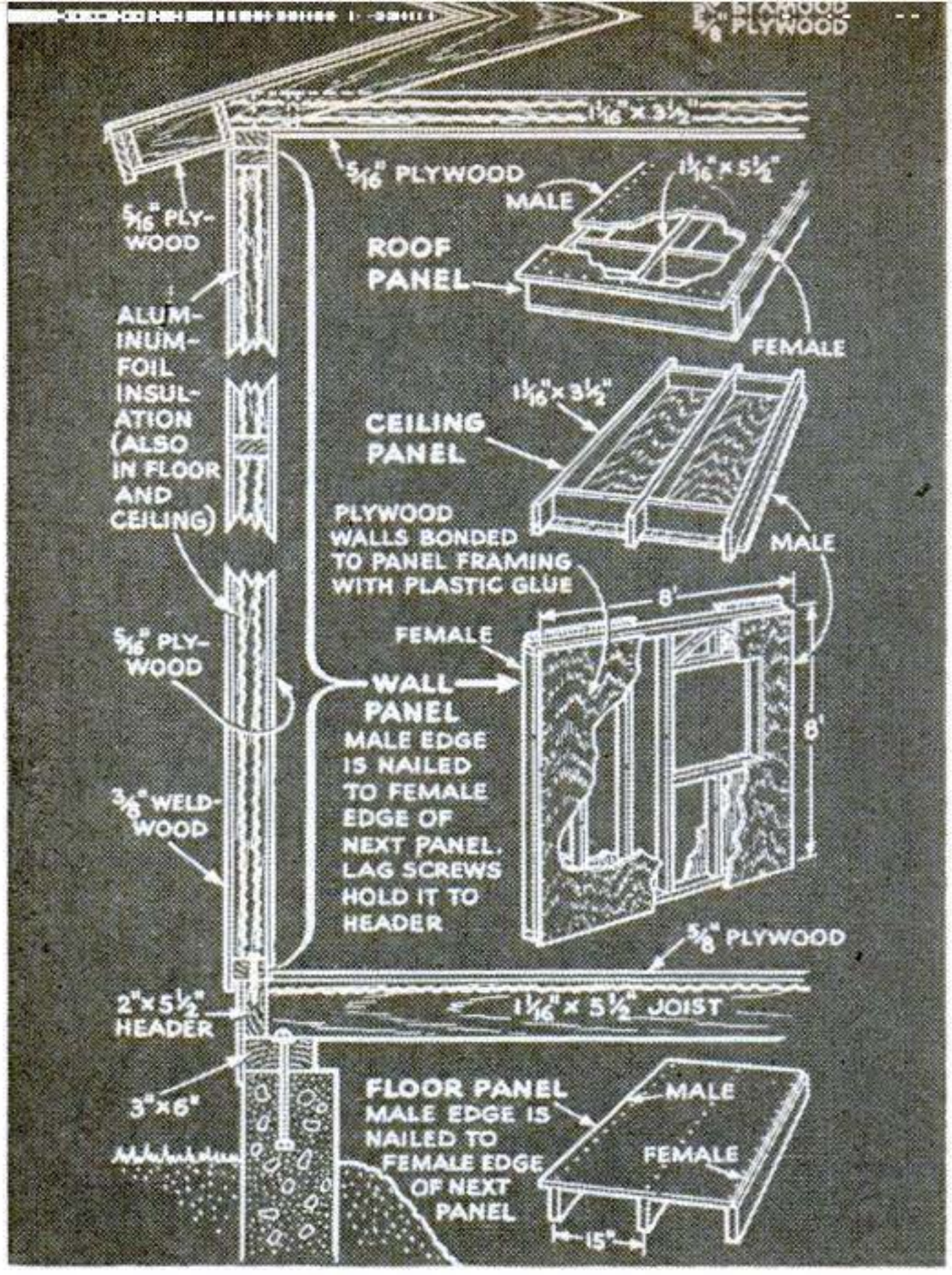
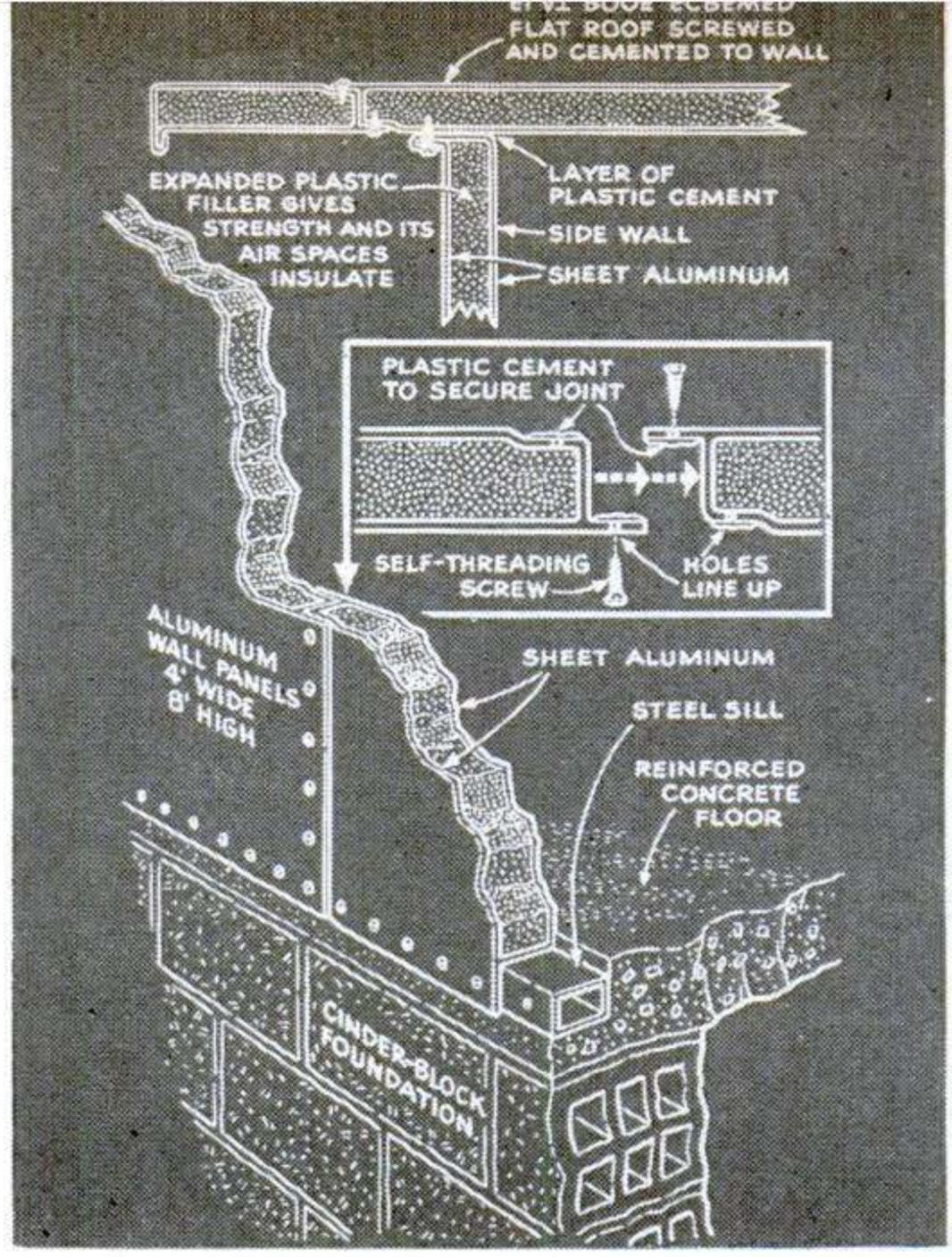


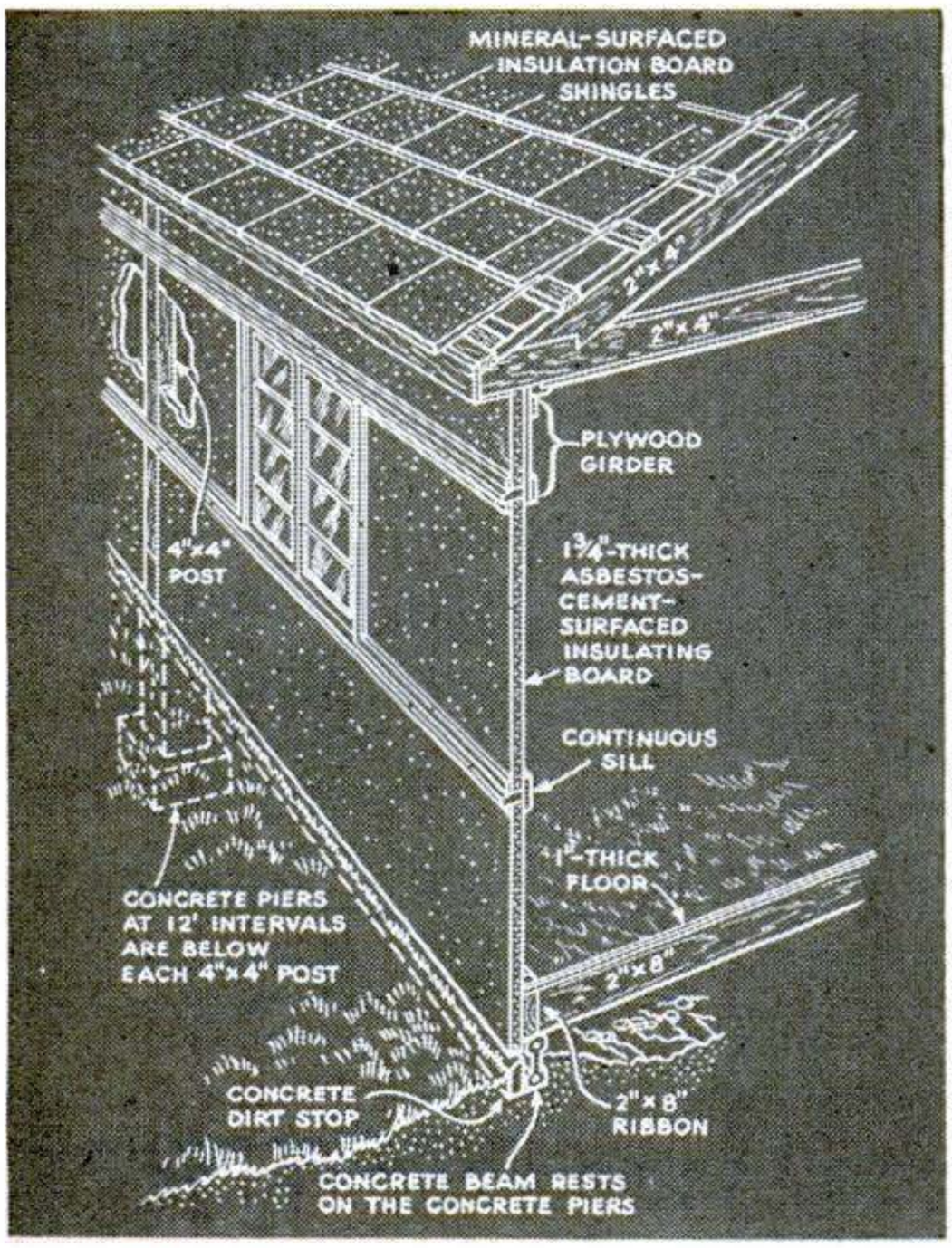
STRESSED-SKIN, PLYWOOD PANELS. A plywood sheet is stretched over a wood frame and attached by plastic glue. By attaching sheets to both sides of a frame and filling the center with insulation, a boxlike structure of great strength is obtained. These 4-by-8-foot panels carry the full weight of the roof. Details above are from the Shelter House.

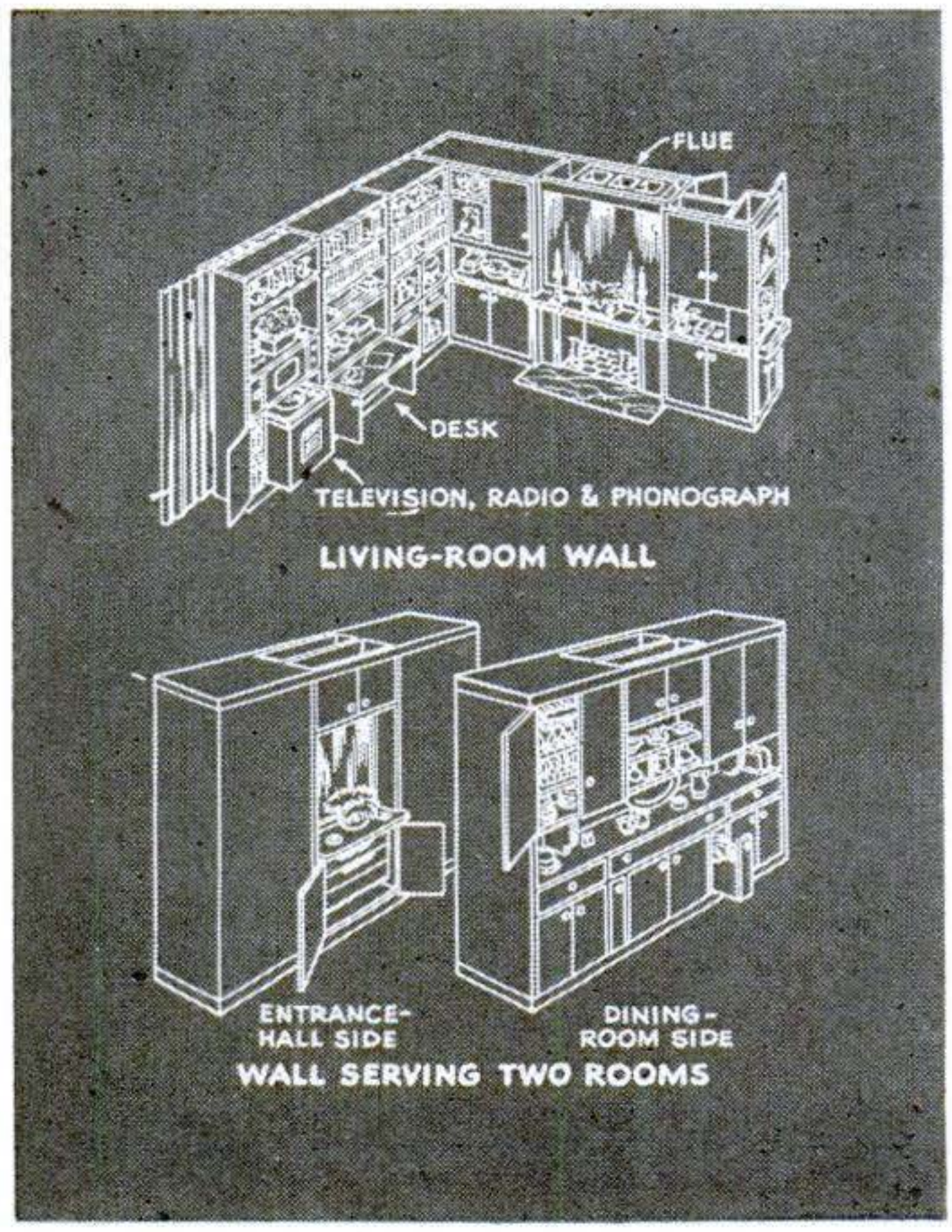


STRESSED-SKIN, METAL PANELS. Newly developed types use metal in the same way. The details above are from the Lincoln House, in which the panels are made of aluminum. An additional feature is an expanded plastic core that adds to the strength of the panels and at the same time provides dead air cells for insulation against climate.

HORIZONTAL PANELS. This involves heavy, widely spaced framing, with the openings taking prefabricated panels. The type shown above was developed by the John B. Pierce Foundation and was used by the Celotex Corporation for war housing.

WORKING WALLS. Some prefabricated houses offer special features, such as these "working walls" used in the Defoe house. Cupboards, shelves, drawers and closets are built right into the walls, providing a maximum of storage space.





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Looking at Outstanding Prefabs

THE big names in prefabrication today include Aladdin, American Houses, Anchorage Homes, Celotex, Continental, Cumberland, Fuller (PSM, May '46, p. 74), General Houses, E. W. Green (PSM, May '46, p. 136), Gunnison, E. F. Hodgson, National Homes, Pease, Precision-Built, Schult, Willisway, and Wingfoot. All of these manufacturers and more are earnestly determined to create a new industry comparable to the auto industry of the twenties. They realize that their first task is to clear the public mind of prejudice. Most of their war work consisted of temporary and portable housing. They now must convince the people that they can also build sound permanent homes.

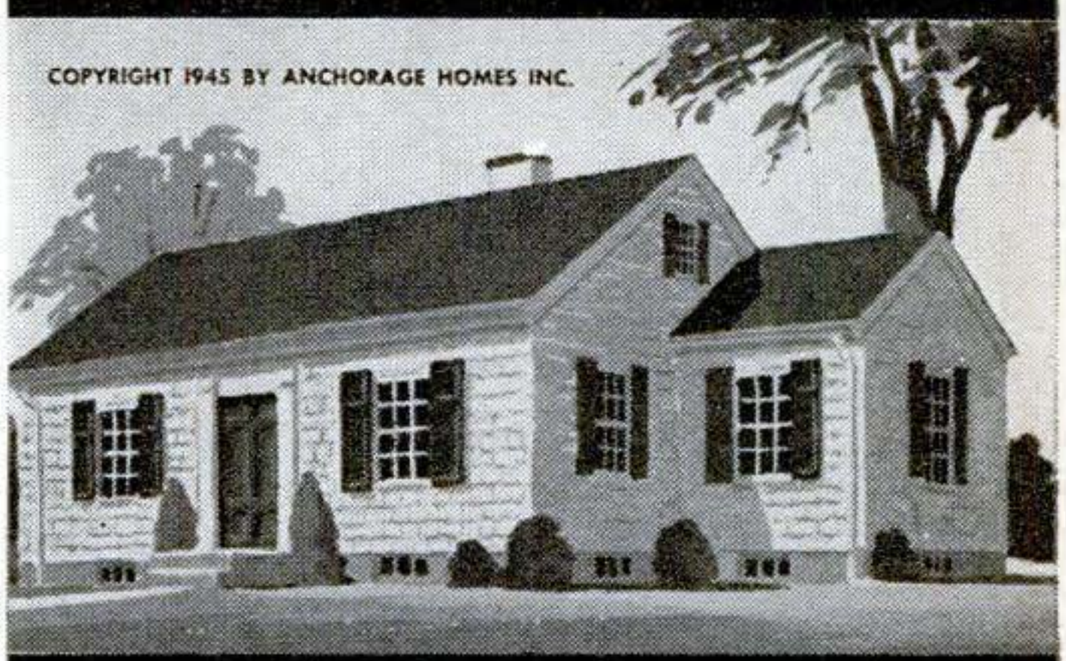
These leading prefabricators vary widely among themselves in manufacturing methods, architectural styles, materials used, and methods of distribution.

American Houses, for example, supplies only a panelized frame, sheathed in, with doors and windows hung and hardware in place. Exterior and interior finish are supplied in bulk for application on the site. American sells its product to local contractors, who determine the final selling price. In style its houses are thoroughly conventional. No seams or battens show outside or in, and there are no other visible marks of prefabrication.

The Homasote company has its own factory-house enterprise in Precision-Built Homes, of Trenton, N. J. If you want a Precision-Built home, you have your architect or contractor submit plans worked out in modular units of measurement specified by the factory. The component parts of your house are then built in the factory and shipped to the site for assembly. A floor section might be 20 feet long, wall sections up to 8 by 21 feet, with inside and outside surfaces attached. Once the pieces come from the factory, the house can be erected in two to three weeks.

Precision-Built plans to sell its homes to individuals through department stores, realtors, operative builders, lumber dealers, and lending institutions. During the present housing crisis, this company is concentrating

GUNNISON: Stressed-skin plywood panels. Sixteen models; 2-3 bedrooms; $5,000-$6,000; plumbing, wiring, heating system. Porch, garage, etc., extra.



ANCHORAGE HOMES: Wooden frames pre-assembled into large panels. 48 New England models; 2-4 bedrooms; all utilities; basement; prices uncertain.

WINGFOOT: Pressdwood exterior, plywood interior. $2,450 f.o.b., delivered as single unit; 2 bedrooms; all utilities; built-in beds and bedroom furniture.

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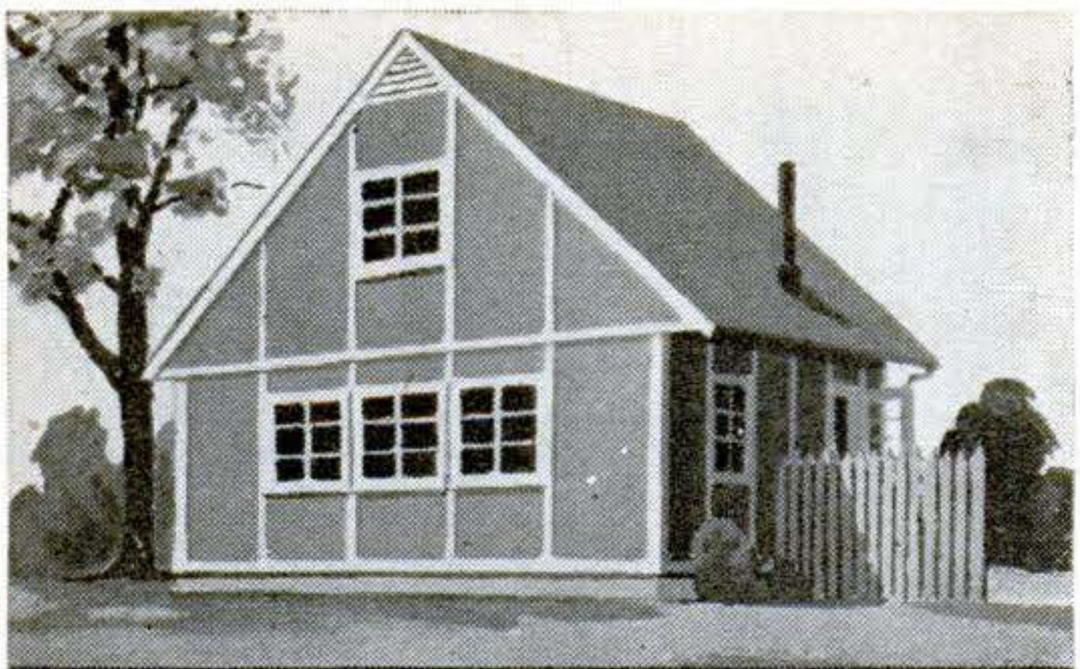
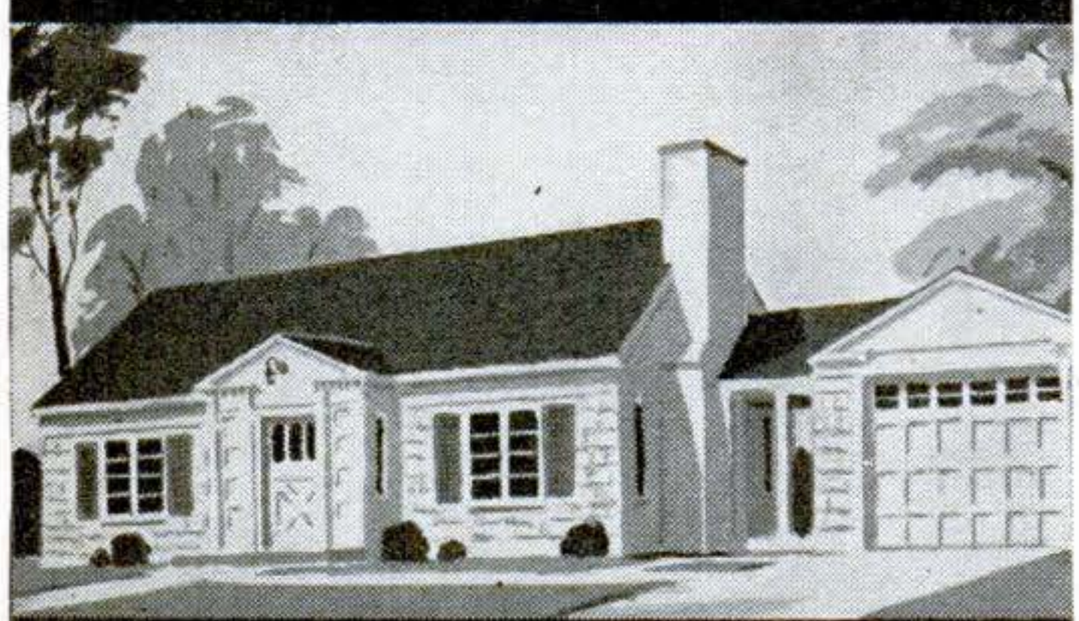
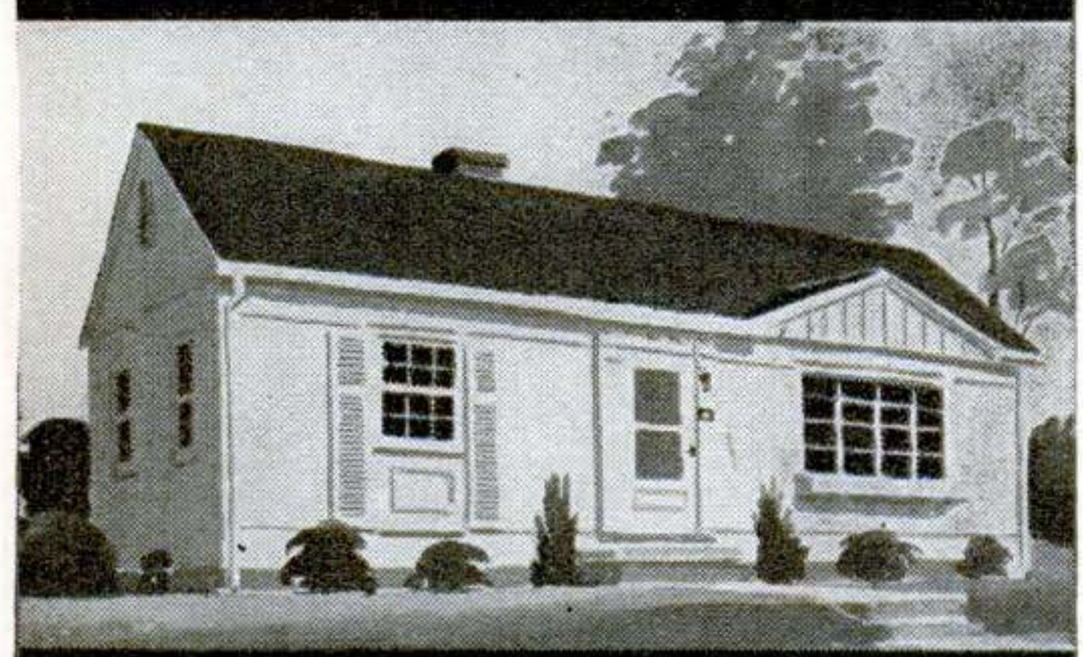


HOME-OLA: Stressed-skin plywood panels. Five rooms; under $3,500; most utilities. Assembly time: 300 hours, local labor. Five other models planned.



DEFOE: Wooden-frame, pre-assembled room-wall-size panels; two standard designs now; wiring, plumbing, heating. De luxe model above. No prices.

SHELTER HOMES: Stressed-skin plywood panels, aluminum-foil insulation; 2 bedrooms; with furnace, plumbing, kitchen equipment, about $6,000 erected.



NATIONAL HOMES: Room-size panels of stud and sheath construction, with steel columns. Nine models; 2-3 bedrooms; $5,400 up, through dealers only.

on two or three standardized designs.

Among the companies that look to lumber dealers for distribution is General Houses, Inc., of Chicago. Their postwar veterans' house will be 25 by 32 feet (800 square feet), with kitchen and utility room, living room, two bedrooms and a bath on one floor. The ceiling beams will be strong enough to support two extra bedrooms and a bath upstairs, if the customer cares to add them later. In that case, two prefabricated dormers can be punched into the roof, and a stairway led up from the living room.

The basic house will be constructed of unusually heavy panels having the thickness of the normal wall. Vertical siding lends the exterior a pleasing appearance and conceals the panel joints; or it can be covered, if the owner wishes, with shingles. Inside, the finish is a smooth-surfaced plaster board, which can be painted, papered or plastered. This neat house will sell for something less than $6,000, according to present plans.

Another house to be sold through lumber dealers is known as the Home-Ola. This was designed and engineered by Jacques and R. J. Willis, heads of the Willisway System. The house is now in production on the West Coast, for distribution there and in the Midwest.

The Home-Ola is of light construction, and aimed at the $3,000 market. The basic model (about 700 square feet) has a 12-by-20-foot living room running along one side of the house, a small kitchen, dinette and bathroom on the other side. A steel stairway in the center leads to two bedrooms (9′x12′ and 12′x12′) on the second floor, with generous closet and storage space under the eaves of the pitched roof. The chassis is of structural steel, walls and partitions of stressed-skin fir plywood panels, resin-glued to both sides of an insulated wood frame. Wide windows and extremely simple lines give the Home-Ola a clean appearance. There are no tricks to disguise its origin.

Gunnison Homes are among the best in the field, though some experts still have doubts about using plywood, as this firm does, for exteriors. Gunnison uses a standard, stressed-skin, four-foot panel, two inches thick, composed of plywood sheets glued to the insulated frame under heat and pressure. Eight basic house designs will be available, reversible to make a total of 16 choices, selling at $4,000 to $8,000, more or less. The smallest size, 24 by 28 feet (672 square feet), has two bedrooms and a 12-by-16-

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foot living room; the largest (1,344 square feet) has three bedrooms and two baths, a 12-by-22-foot living room and a dining alcove. All are one-story houses, can be built with or without a basement.

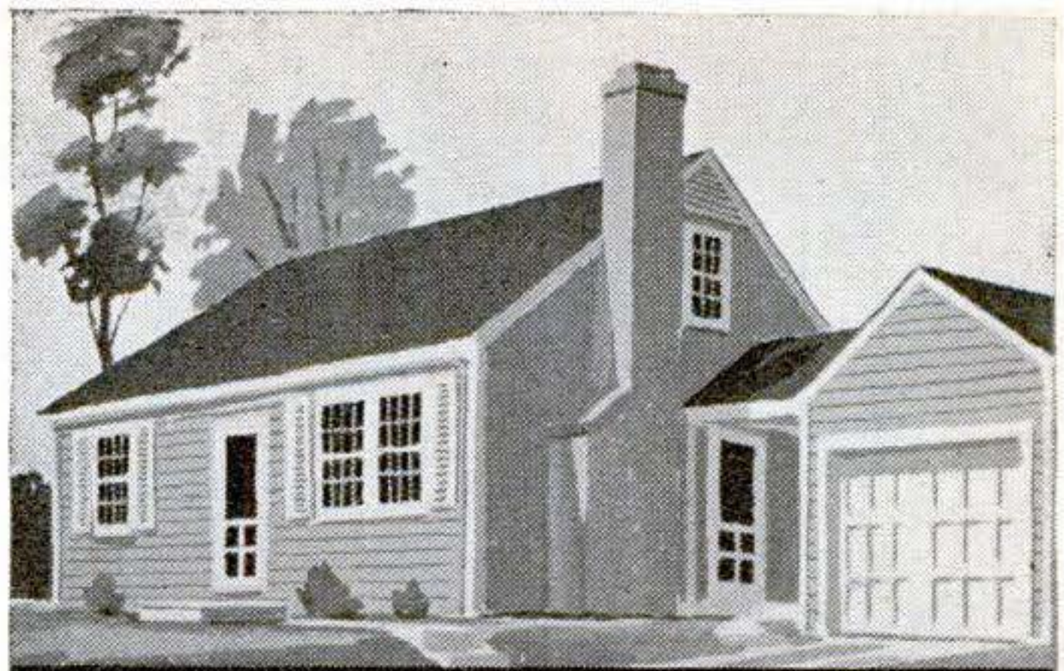
While the basic floor plan for each model is standardized, the customer can achieve variety by making use of some of the ingenious accessories that Gunnison sells at slight extra cost. One of them is a wing "package", which attaches to any corner and lengthens that room by four feet. Other "packages" include a side or front porch, fireplace, breezeway or arcade, and garage.

Interiors of the Gunnison home are of plywood. At close quarters you can see the joints between plywood panels. Corner joints are finished with a strip of molding. The total effect is different, of course, from the conventional plaster wall, but people who have lived in these homes say a seamless surface is not indispensable.

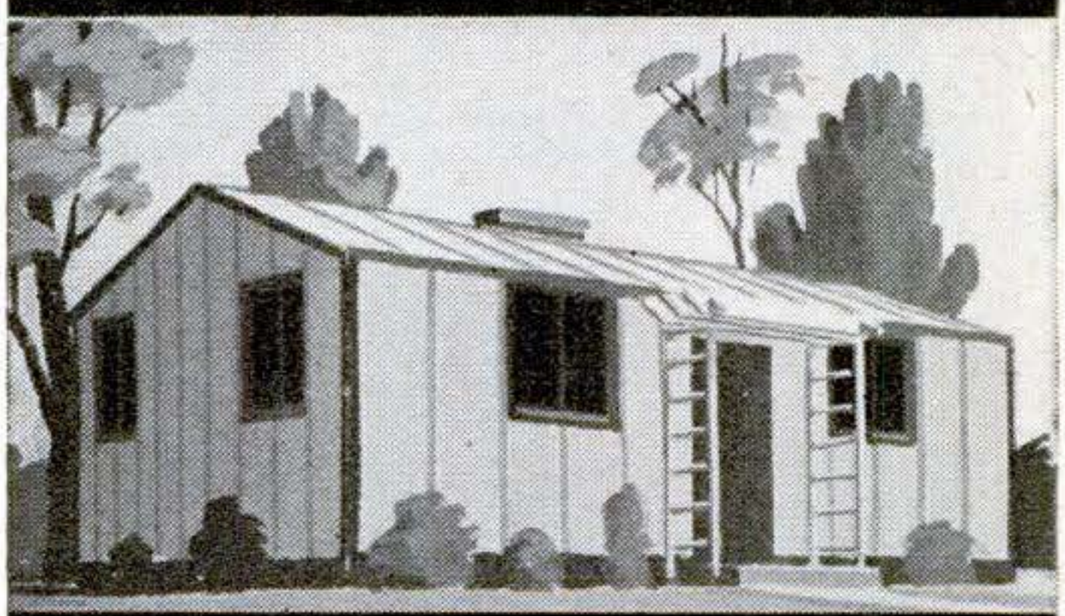
Through its subsidiary, Wingfoot Homes, Goodyear Tire and Rubber Co. has been experimenting with an extremely low-cost home intended to sell for less than $2,000. Though designed as a permanent home, the Wingfoot is demountable and can move with the occupant if the mortgage permits. It is, in fact, something like an overgrown trailer. Also like a trailer, it is built complete in the factory and hauled to the site. This means that the main living quarters of the 26-foot structure can be only eight feet wide. Once located on the site, the bedroom wings are pulled out like drawers, to yield a T-shaped, flat-roofed house 15 feet wide at its widest point, with two tiny bedrooms, bath, and combined kitchen-living room.

It is unfair, of course, to apply to a prefab more rigid requirements than one would demand of a conventionally constructed house. You may as well know now that if you live in a city with a restrictive building code you probably cannot buy a prefab at all. Instead of requiring certain degrees of performance to protect the public health and safety, many codes lay down rigid specifications on materials and methods that eliminate prefabricated construction even when it surpasses the performance standards.

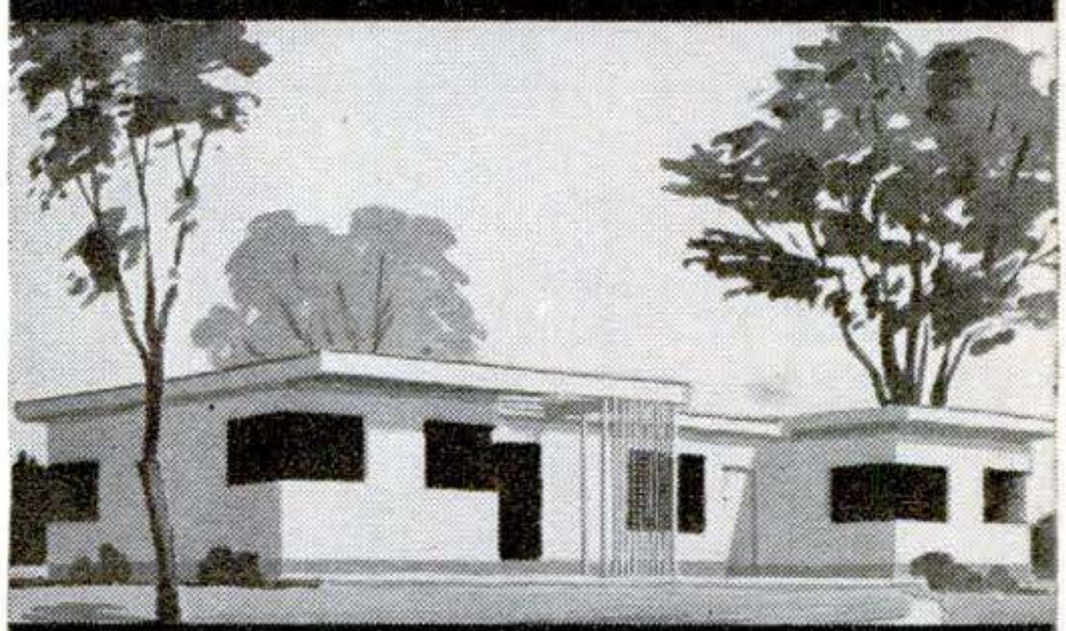
In some areas, also, union labor will be hostile to the entrance of prefabs. But if you want one badly enough, and if the housing shortage is acute in your community, public opinion should be strong enough to override these obstacles. That is a matter for you and your community.



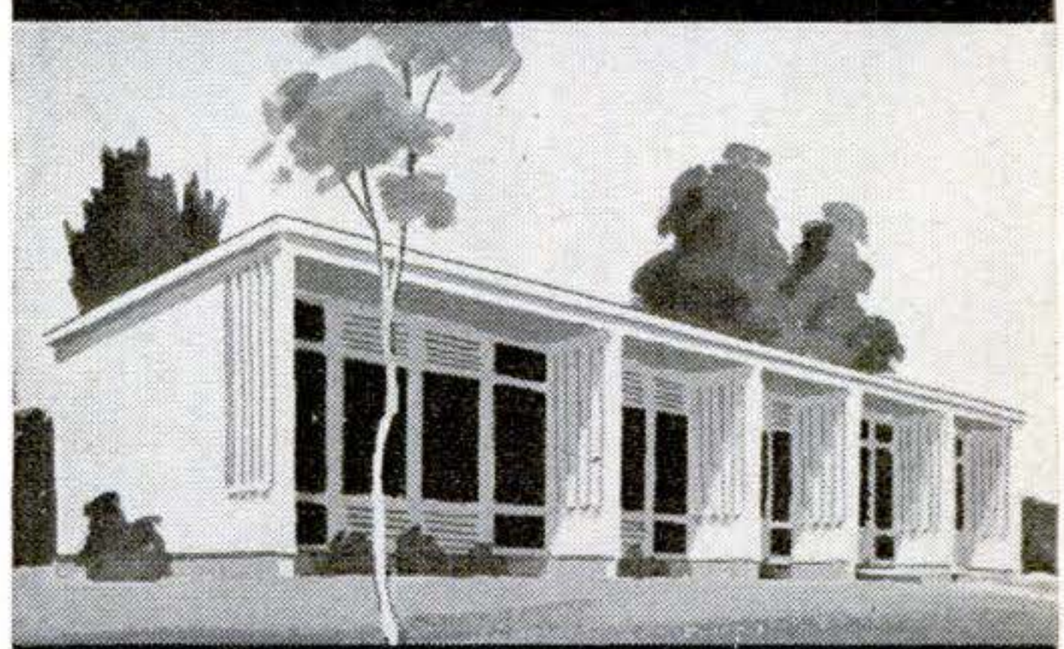
AMERICAN HOUSES: Wooden frames pre-assembled into panels. Wholesale only to contractors; only outside shell and interior partitions provided.



STEELCRAFT: Aluminum sheets bolted to steel frames. One room with kitchen and bath, $994; larger units $1,490 up; utilities extra. Now available.



LINCOLN HOUSES: Aluminum stressed-skin panels joined by plastic; 4 rooms, with kitchen, bathroom equipment, about $3,000. Heating unit extra.



GREEN'S SOLAR HOUSE: Stressed-skin panels; one bedroom with "3-bedroom efficiency;" folding walls; about $6,500. Now making non-Solar prefab.

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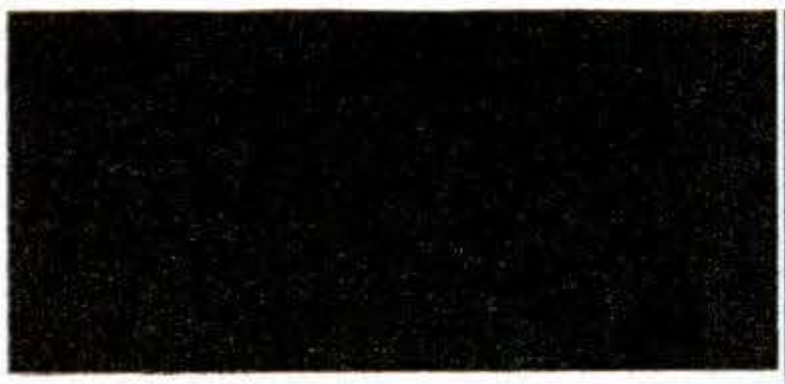

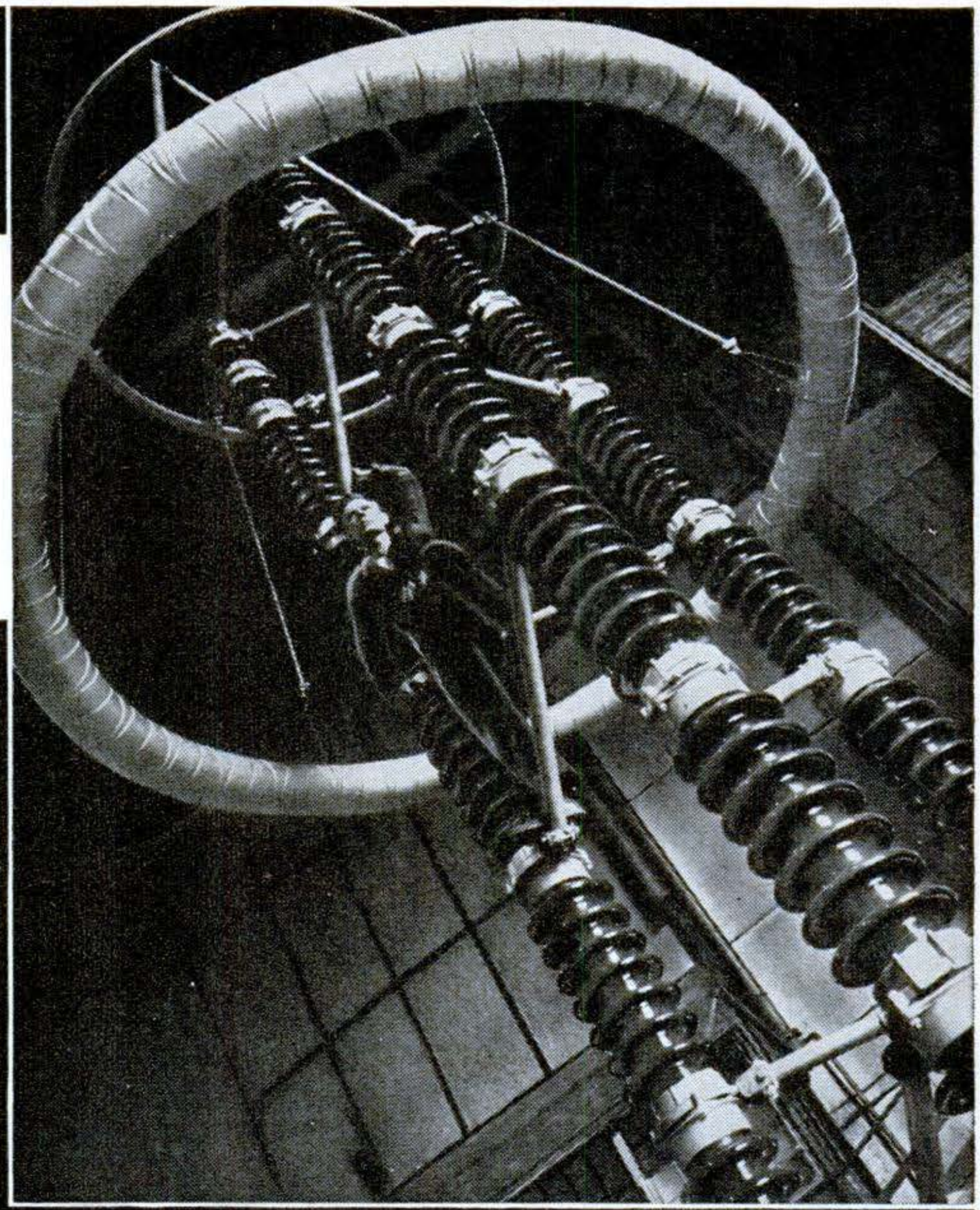

A lightning bolt strikes the Empire State Building. The single stroke (center) was photographed with a fixed lens, the broader image (inset) with a high-speed rotating lens that reveals the bolt's duration and the fact that it consists of several discharges along one path. Right, the world's largest lightning arrester, a 40-foot Westinghouse experimental model, for use on a 500,000-volt power line.

Race Tracks for Thunderbolts

Until science knows more about lightning, best way to handle it is to speed it on its way.

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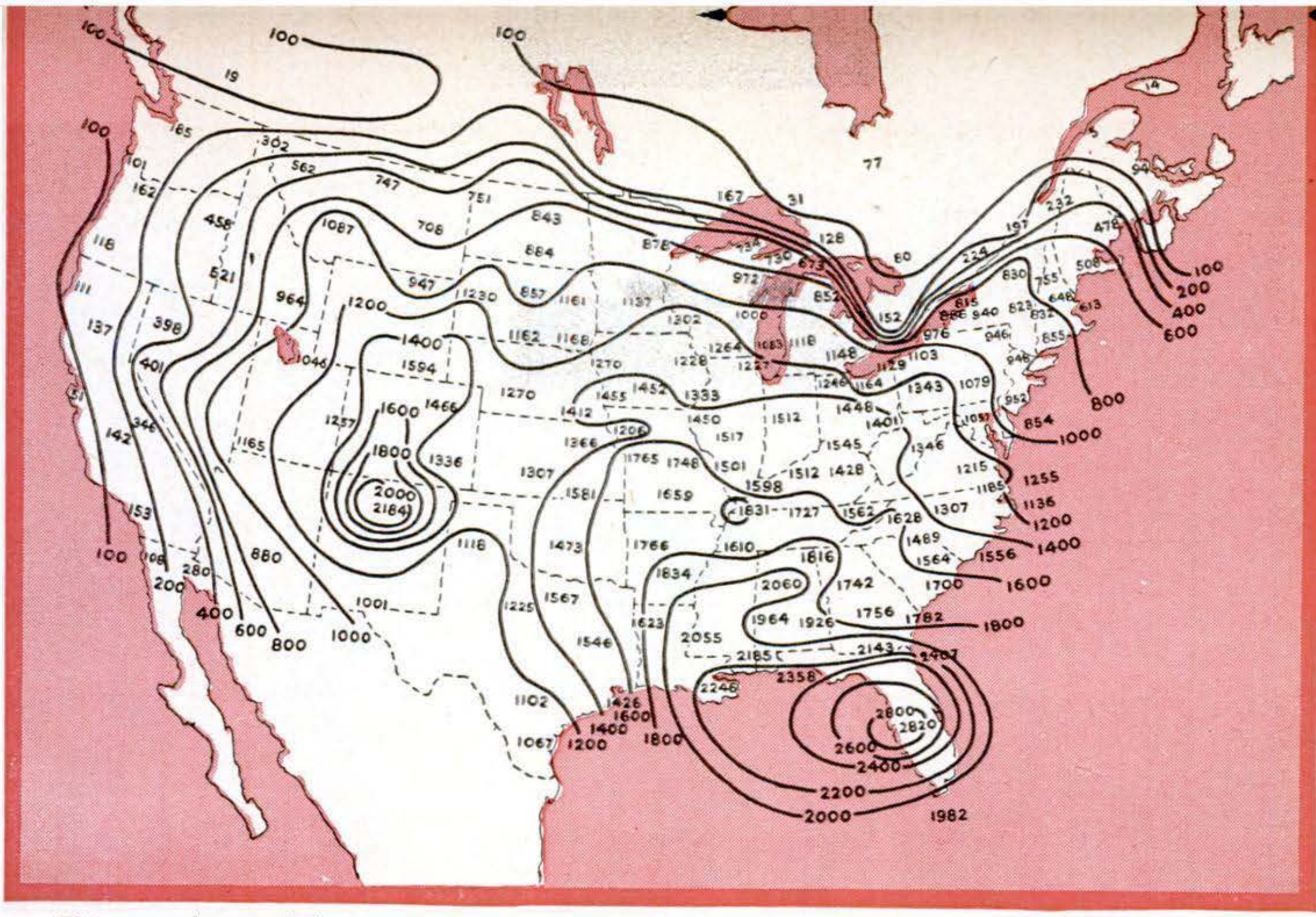

This unusual map of the United States shows where and on how many days thunderstorms occurred during the 30 years from 1904 to 1934. It is called an isoceraunic (equal thunder and lightning) chart.

By GOLD V. SANDERS

IF AUGUST maintains its 10-year record as the worst month for thunderstorms throughout the United States, lightning will strike some 700 persons and kill 100 of them during the next 31 days. There will be an average of nine electrical storms in every part of the country.

But in one important respect lightning will do less damage this year than ever before. In most storms electrical service will be steadily maintained; there will be very little "outage." Twenty years ago, every one of the 50 or more bolts that struck each 50-mile stretch of transmission line in the course of a year knocked out service at least temporarily. With modern scientific apparatus for enticing lightning away from electrical systems, service over such a 50-mile line will not be disrupted more than once in five or 10 years.

Several types of devices provide this notable protection. The simplest and perhaps most effectual is the "overhead ground wire," installed singly or in pairs at the tops of towers carrying the lines across country. These wires are essentially horizontal lightning rods. They form a protective umbrella for the conducting wires. Being grounded to the steel towers, rather than insulated from them, they quickly conduct lightning strokes to the ground.

Other devices are improperly called lightning "arresters"—the last thing electrical engineers want to do with lightning is to arrest it. These arresters are designed to give lightning an outlet to the ground as soon as possible after it has struck a transmission line.

A lightning arrester may be small and simple or huge and costly. Essentially, it is a dump valve for electrical current. Ordinarily, it is closed and remains so until the electrical potential rises to a value such as a surge of electricity from a lightning bolt creates. Then the arrester "opens" and conducts the destructive charge to the ground. After this it immediately closes and again becomes an insulator rather than a conductor. Electricity from the power plant resumes its flow through the line with only a momentary interruption.

Before electrical scientists could provide shorter, more attractive paths for lightning to follow than a building, transmission line, or human being, they had to learn more

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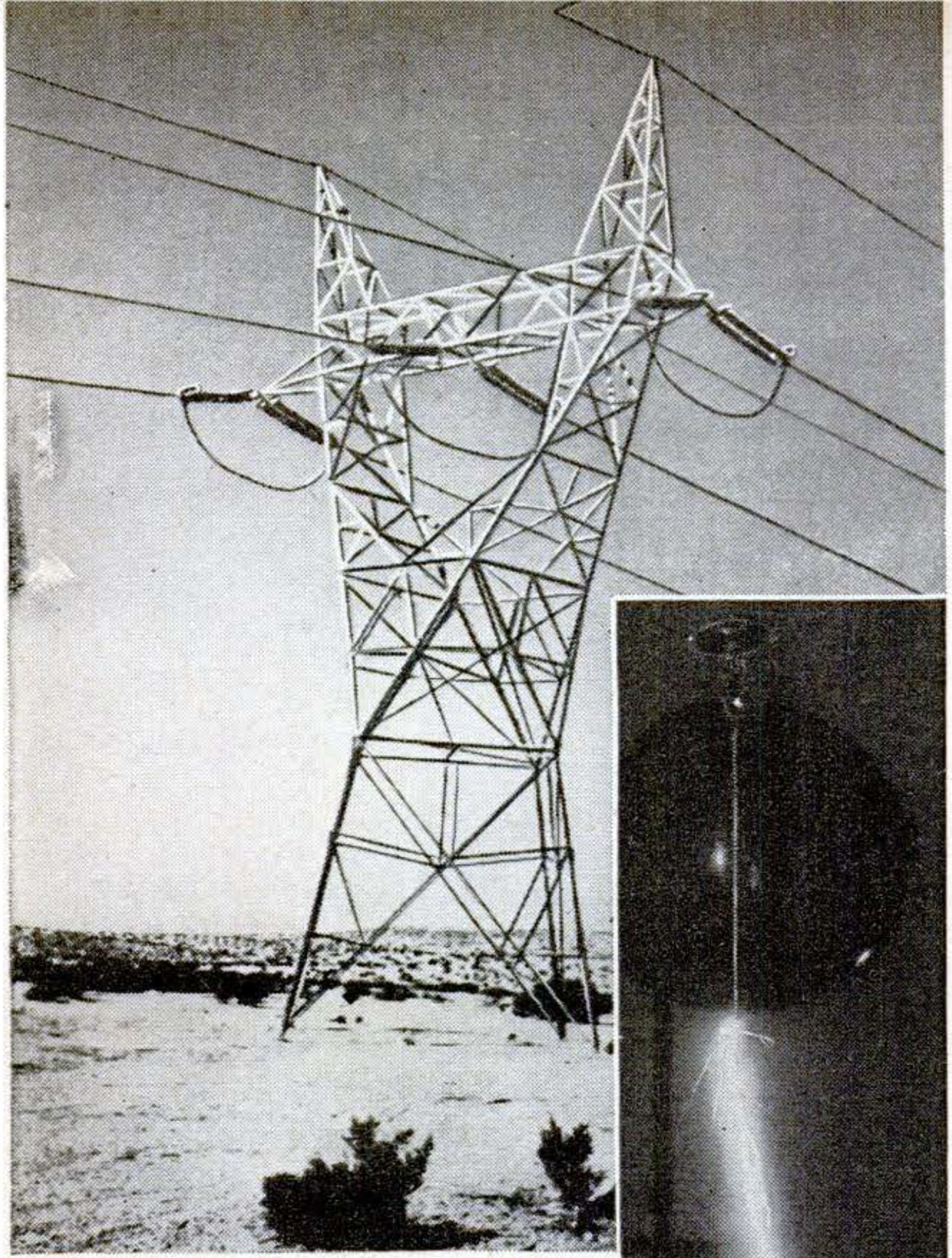

The two top wires on this transmission line are actually horizontal lightning rods grounded to the steel towers. Man-made 3,000,000-volt bolt (right), created by surge generator, knifes through pine plank in a laboratory where protective devices for power lines undergo tests.

about the nature of the dazzling, crashing bolt. Their senses were unreliable guides. The human eye, for instance, tells us that a streak of lightning has flashed down from a cloud and struck something on the earth. Ultra-high-speed cameras have shown, on the contrary, that a lightning flash consists of as many as 20 discharges, and that most of them *pass upward from the earth to the clouds.* All this takes place in a fraction of a second—and is measured in millionths of a second by cameras exposing film at the rate of a mile a minute.

General Electric engineers have photographed 68 lightning strikes on the Empire State Building in three years. The pictures revealed that practically all of them began with leaders reaching up from the tip of the radio antenna toward the clouds. Other photographs showed similar leaders reaching down from a cloud toward the earth, extending themselves by stages relatively slowly but too fast for the eye to detect. When the streamers from above and below make contact, the real fireworks start. There may be one immense discharge along this path, or a number of them.

The cathode-ray oscillograph, another important instrument of lightning research, has recorded 12 discharges within a quarter of a second. Some are what the scientists call "continuing," some are briefer than others, and the voltage varies widely. The continuing discharge is the one that starts fires—others pass too swiftly, merely tearing things apart.

Higher than anything else around it, the Empire State tower is struck by many bolts of lightning. All of them are harmless, though, because the steel structure is a perfect lightning rod with a good ground connection. The 1,250-foot building also provides protection for other buildings within a radius of about 1,250 feet. Experiments have demonstrated that lightning rods and other well-grounded metal projections "attract" the lightning within a certain area, though scientists would not use that word to describe the phenomenon. The Empire State Building is the lightning rod shielding a large neighborhood; it provides a "cone of protection."

Scientists have calculated that *a lightning stroke that can smash a house actually has only enough energy to light a bulb for a few minutes.* What makes lightning destructive is the immense speed with which its voltage builds up.

Scientists hope to know even more about lightning by November. The Army, Navy, and U.S. Weather Bureau plan to send pilotless and piloted planes and balloons into Florida storm centers this summer and fall, with special instruments to report the inside story of a thunderstorm.

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Bikini Was Like This—

010701Z VIA NAVY RADIO ¶ TEST ABLE OF OPERATION CROSSROADS WAS A MORE IMPRESSIVE DEMONSTRATION OF TOMORROW'S TOOLS THAN OF NUCLEAR FISSION. MILLIONS OF DOLLARS WORTH OF INSTRUMENTS WERE USED TO RECORD THE LIGHT, HEAT, BLAST PRESSURE, RADIATION AND AFTERMATHS OF THE EXPLOSION. AND THE EXPLOSION ITSELF STARTLED ME LESS THAN THE EXCELLENT PERFORMANCE OF THOSE INSTRUMENTS. THEY ARE THE TOOLS WITH WHICH WE WILL HAVE TO PROTECT OURSELVES WHILE DEVELOPING ATOMIC ENERGY FOR OTHER PURPOSES.

I WAS ONE OF THREE WRITERS WHO WERE PERMITTED TO SEE THE BOMB'S FLASH OF LIGHT FROM THE SKYDECK OF THE PRESS SHIP APPALACHIAN THROUGH AN ICAROSCOPE. THIS IS AN ELECTRICALLY OPERATED INSTRUMENT WHICH WAS DEVELOPED DURING THE WAR TO ENABLE A MAN TO SPOT AN AIRPLANE SPEEDING TOWARD HIM DIRECTLY IN LINE WITH THE SUN. IT WAS NAMED AFTER ICARUS, THE MYTHICAL GREEK WHO FLEW SO CLOSE TO THE SUN THAT HIS WAX WINGS WERE MELTED AND HE FELL INTO THE SEA. IT LOOKS LIKE A SHORT STUBBY TELESCOPE BUT IT DOES NOT MAGNIFY THE SCENE. INSTEAD IT PERMITS A PERSON TO SEE THINGS IN A FLUORESCENT SCREEN WHICH ARE SO BRIGHTLY ILLUMINATED THAT HE COULD NOT SEE THEM BY LOOKING DIRECTLY AT THEM. THE ICAROSCOPE WAS, UNTIL TEST ABLE, ANOTHER OF AMERICA'S MANY WAR SECRETS.

FORTY OF APPROXIMATELY 100 DIFFERENT TYPES OF INSTRUMENTS THAT WERE USED TO OBSERVE THE EXPLOSION OF THE

FOURTH ATOMIC BOMB IN HISTORY ARE STILL SECRET. THEY CANNOT EVEN BE NAMED. THE 60 OTHERS RANGED FROM ORDINARY FIVE-GALLON GASOLINE CANS, WHICH ARE EXCELLENT PRESSURE GAUGES, TO COMPLEX BOLOMETERS FOR MEASURING THE HEAT AT VARIOUS POINTS THROUGHOUT THE VAST AREA AFFECTED BY THE BOMB.

TELEMETERING INSTRUMENTS ALONE REPRESENTED AN INVESTMENT OF MORE THAN $1,000,000. THESE ARE DEVICES WHICH MAKE SCIENTIFIC MEASUREMENTS POSSIBLE FROM SAFE DISTANCES. THEY WERE STREWN AROUND AND THROUGHOUT THE 73 FLOATING TARGETS. IF THEY OPERATED AS SUCCESSFULLY AS THE TELEVISION EQUIPMENT WHICH NEWSPAPERMEN USED ON THE APPALACHIAN, THE TECHNICIANS ACQUIRED VOLUMES OF STATISTICAL DATA.

IT WAS POSSIBLE AT ANY TIME ON THE MORNING OF JULY 1 TO STEP INTO THE WARDROOM OF THE PRESS SHIP AND SEE THE BIKINI BEACH AND THE MILES-WIDE TARGET MORE CLEARLY THAN IT COULD HAVE APPEARED THROUGH A BOMBSIGHT FROM AN ALTITUDE OF 30,000 FEET. TROPICAL TREES WAVED GENTLY IN THE FOREGROUND OF THE GREENISH MOVING PICTURES TRANSMITTED BY ROBOTS IN THE TOWERS ON BIKINI. EVEN A LANDLUBBER COULD RECOGNIZE THE SILHOUETTE OF A CHRISTMAS TREE ON THE HORIZON AS THE WEIRD SUPERSTRUCTURE OF ADMIRAL YAMAMOTO'S FORMER FLAGSHIP, THE DECREPIT BATTLESHIP NAGATO. AND EXPERTS COULD QUICKLY SPOT THE SILHOUETTES OF OTHER SHIPS. THE FIRST HINTS OF FIRES ABOARD THE SHIPS WERE THE WISPS OF SMOKE SEEN RISING FROM THOSE BLACK SLIVERS ON THE FLICKERING SCREENS, AND THE FIRST NEWS OF SERIOUS DAMAGE CAME FROM THE MEN WHO WERE WATCHING THE TARGET THROUGH THE ELECTRONIC TUBES.

AT FIRST THE TEST SEEMED FAR MORE THEATRICAL THAN SCIENTIFIC. THE NIGHT BEFORE THE BOMB WENT OFF THE LIGHTS OF THE TARGET FLEET, ROCKING GENTLY IN THE LAGOON, TWINKLED AS GAILY AS THOSE OF A SEASIDE RESORT. OVERHEAD THE SKY WAS SO CLEAR AT TIMES THAT THE MILKY WAY RESEMBLED BROADWAY. THE BRIGHT RED BATTLESHIP NEVADA LOOKED LIKE THE SETTING FOR A BILLY ROSE SHOW AND THE TANKS, GOATS AND MILITARY GEAR ON HER DECK SEEMED LIKE CIRCUS PARAPHERNALIA WHEN THE SUN ROSE.

ON ABLE DAY WE FELT, IN FACT, LIKE SMALL BOYS WAITING

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FOR A CIRCUS TRAIN. THERE WAS THE SAME HIGH HOPE OF A GREAT THRILL, AND THE SAME MOMENTARY DISAPPOINTMENT WHEN THE BOMB BURST THAT ONE FEELS WHEN A CIRCUS ACT PROVES LESS EXCITING THAN ITS BILLBOARD POSTERS.

BEFORE THE SOUND OF THE BLAST REACHED US, MANY OF US HAD TURNED TO STARE AT EACH OTHER, WONDERING IF THE PLUTONIUM CHAIN REACTION HAD NOT FIZZLED. I FELT NO HEAT OR PRESSURE. LOW CLOUDS OBSCURED THE VIEW FROM THE APPALACHIAN LIKE PILLARS IN A THEATER. BUT THE ATOMIC BOMB'S SMOKE BURST THROUGH THEM AS IT SHOT UPWARDS FOR THOUSANDS OF FEET IT THEN RESEMBLED A KAHILI, AN ANCIENT SYMBOL OF POWER CARRIED BY THE NOBILITY AMONG PRIMITIVE PEOPLES OF REMOTE PACIFIC ISLANDS LONG AGO. KAHILIS WERE BEAUTIFUL, THICK PLUMES OF FEATHERS MOUNTED ON THE UPPER ENDS OF LONG POLES, WHICH SOMETIMES INCLUDED PARTS OF HUMAN BONES. THIS MODERN AMERICAN KAHILI WAS AN EVEN STRANGER DEVICE. IT SEEMED TO MERGE INTO THE CLOUDS QUICKLY, BUT IT STOOD OUT CLEARLY MORE THAN AN HOUR LATER, ITS WHITE CIRCULAR CROWN STILL SPINNING.

THEN, AS WE CREPT BACK TOWARD THE LAGOON AND ACTUALLY SAW THE FIRES WHICH WE HAD SEEN PREVIOUSLY ON THE TELEVISION SCREEN, REPORTS OF HEAVY DAMAGE TO COMBAT SHIPS FILLED US WITH AWE OF THIS STRANGE WEAPON.

THE INDEPENDENCE LOOKED AS IF SHE HAD BEEN HIT BY KAMIKAZES. THE ARKANSAS, SKATE, PENSACOLA AND OTHER VESSELS WERE IN BAD SHAPE. THE RED PAINT WAS NO LONGER ON THE NEVADA, AND THE EXPLOSION EFFECTS WERE VISIBLE NOT ONLY IN THE CENTER BUT OUT ON THE EDGES OF THE TARGET. THE WHOLE FLOATING GAUGE, IN OTHER WORDS, HAD REGISTERED VIOLENCE.

THE MEANS OF DETECTING THE INVISIBLE, INAUDIBLE, AND ODORLESS RADIATION, WHICH CAN HAVE SUCH STRANGE RESULTS, WERE SO ERECTED BEFORE TEST ABLE, HOWEVER, THAT FIRE-FIGHTING CREWS WERE AT WORK WITHIN THE DISHEVELED WHEEL OF TARGET SHIPS A FEW HOURS AFTER THE EXPLOSION.

AS MANY AIRPLANES AS THERE WERE TARGET SHIPS HELPED TO PHOTOGRAPH THE CLOUD, ANALYZE THE AIR, TAKE SAMPLES OF

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THE WATER AND MAKE THE MEASUREMENTS REQUIRED TO FILL GAPS IN THE DATA ACQUIRED AT ALAMOGORDO, HIROSHIMA AND NAGASAKI. THESE INCLUDED DRONES THAT SPED THROUGH AREAS WHERE NO MAN COULD VENTURE.

TRUE EVALUATION OF THIS TEST WILL NOT BE POSSIBLE FOR MONTHS, BUT THERE WAS NO QUESTION A FEW HOURS AFTER THE BLAST ABOUT THE SUCCESS OF THE DRONES. ONE NAVY DRONE HAD BEEN TOSSED UPWARD 6,000 FEET, BUT EVEN SO THE PILOT OF ITS MOTHER PLANE HAD GOTTEN IT BACK UNDER CONTROL. NONE OF THIS COULD BE SEEN FROM THE PRESS SHIP.

NORMALLY, FROM 5,600 TO 6,000 MEN WOULD HAVE BEEN ABOARD THE SHIPS THAT FELT THE ATOMIC BOMB'S FURY. WHAT WOULD HAVE HAPPENED TO THEM WILL NOT BE KNOWN FOR CERTAIN UNTIL ALL OF THE FINDINGS ARE ASSEMBLED. THIS MUCH WAS OBVIOUS WHEN THE SUN WENT DOWN IN MICRONESIA: THE ATOMIC BOMB CANNOT BE COMPARED TO THE WEAPONS USED IN THE PAST. IT IS SO WEIRDLY LETHAL THAT THOSE WHO DIE FIRST IN AN ATOMIC WAR WILL BE THE LUCKIEST PEOPLE.

BIKINI, ONE REALIZED AS MORE REPORTS POURED IN, COULD NOT BE CLASSED WITH CIRCUSES BECAUSE IT WAS NOT ONLY TOO GRIM BUT ALSO TOO VAST AN EXPERIMENT.

VOLTA TORREY CROSSROADS CORRESPONDENT
USS APPALACHIAN JOINT TASK FORCE 1.

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Any Old Craft in a Shortage

EVERYTHING but a street address comes with this home reconverted from a British landing craft. Consisting of kitchen, hall, lounge, bath, and two bedrooms, it is completely fitted for occupancy except for bedding. The home costs £935, or approximately $3,770 in U. S. money. That is about half what it cost the British government as a wartime assault boat.

At its mooring (top) the occupants walk the plank going and coming. Shown in the center photo is one of the bedrooms, with running water, two single beds, full-length wardrobe and cupboard. The door leads out to a bow vestibule. The kitchen (bottom), in metal and enamel, has a gas oven, stainless metal sink, aluminum-covered table, drainboard, and insulated larder. Paintwork is white enamel, and utensils are furnished.

OUR *JET*

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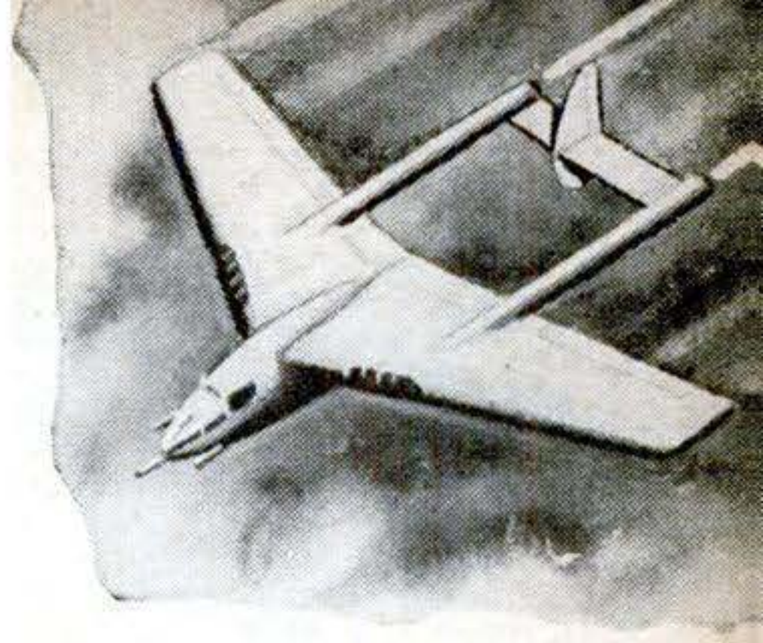
AIR FORCE



By LEON SHLOSS
and DAVID P. McNAMARA

ON A warm summer night the great industrial area defined by Boston, Chicago, the Ohio River and Baltimore lies sleeping. From 5,000 miles away, over the polar region, flashes an enemy air force of 1,000 jet bombers. Equipped only with the best conventional warplanes and a few jet interceptors, the AAF fights desperately but futilely. The inherent characteristic of air warfare, that the advantage lies with the attacker and that *all* attacking planes can never be turned back, holds true again. More than 250 of the enemy bombers get through and drop their atom-bomb loads. America's industrial heart is destroyed. The country has been rendered incapable of waging war. All has been lost in a matter of minutes.

It is to keep such a nightmare from becoming a reality that the United States is building a complete jet-propelled air force —to counter speed with greater speed, to intercept and destroy so much of such an attacking force that the remainder cannot inflict fatal damage.

Army Air Forces high commanders declare the effectiveness of the new jet air force will be in direct proportion to the money and brains applied to comprehensive research and development. Construction, training and maintenance are under way; the immediate goal is a balanced, operational body by 1949.

Advantages of the new instrument are speed, simplicity of production, ease of training and maintenance, and ultimate economy. When jet planes and engines are produced in volume, they will cost less to build than so-called conventional aircraft.

The greatest advantage is speed. The AAF realizes that the guided missile, the atom bomb, and jet propulsion itself have robbed the U. S. of two great defensive advantages traditionally held—space between this country and potential attackers, which could not be spanned by weapons of five years ago, and time in which to turn American natural resources into war weapons.

Remarkable progress has been made. In England, which took the lead in jet development, it was only in 1941 that the first plane flew. In the same year, Lockheed offered the AAF a jet design, but its P-38 Lightning fighters were in such war demand that jet work was tabled. It was not until January 1944 that announcement of the British plane, and the first American plane, was made (PSM, Apr. '44, p. 85). But despite the short history of jet production, that American plane, the Bell P-59, has long been obsolete.

In less than three years, the AAF has prepared this line-up—ready and pending—of the new jet air force:

Fighters:

P-79—Flying Ram, by Northrop. Speed, 525 m.p.h. Ceiling, 40,000 ft. Armament, four .50 caliber machine guns. This tailless, sweptback-wing design is so constructed as to enable its use as an aerial ram. The specially-built wing will chop off parts of enemy planes. The pilot flies in a prone position, eliminating blackouts. Plane's primary use will be short-range interception.

P-80—Shooting Star, by Lockheed. Speed, 550 m.p.h. Ceiling, 45,000 ft. Armament, six .50 caliber machine guns. Currently the AAF interceptor, in the jet air force it probably will become the long-range escort. It also could be used for intruder work.

P-81—Consolidated-Vultee. Speed, 550 m.p.h. Ceiling, 40,000 ft. Long-range escort.

P-83—Bell. Speed, 550 m.p.h. Ceiling, 40,000 ft.

P-84—Thunderjet, by Republic. Speed, 590 (plus) m.p.h. Ceiling, 40,000 ft. This plane probably will become the primary interceptor.

P-86—North American. All details restricted.

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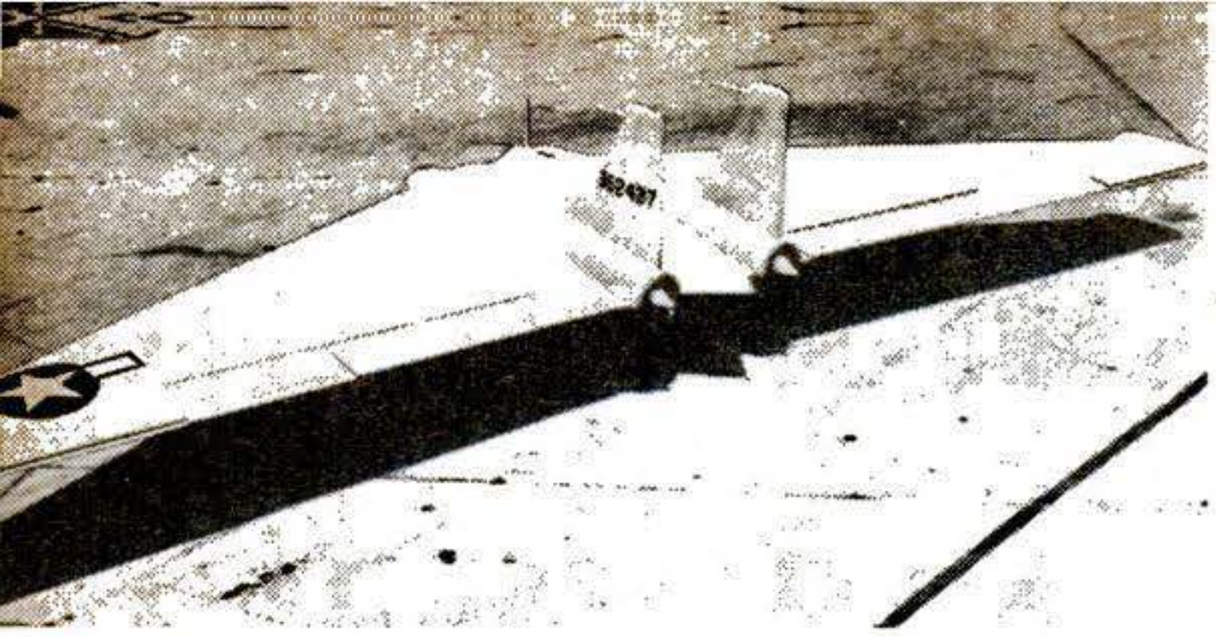
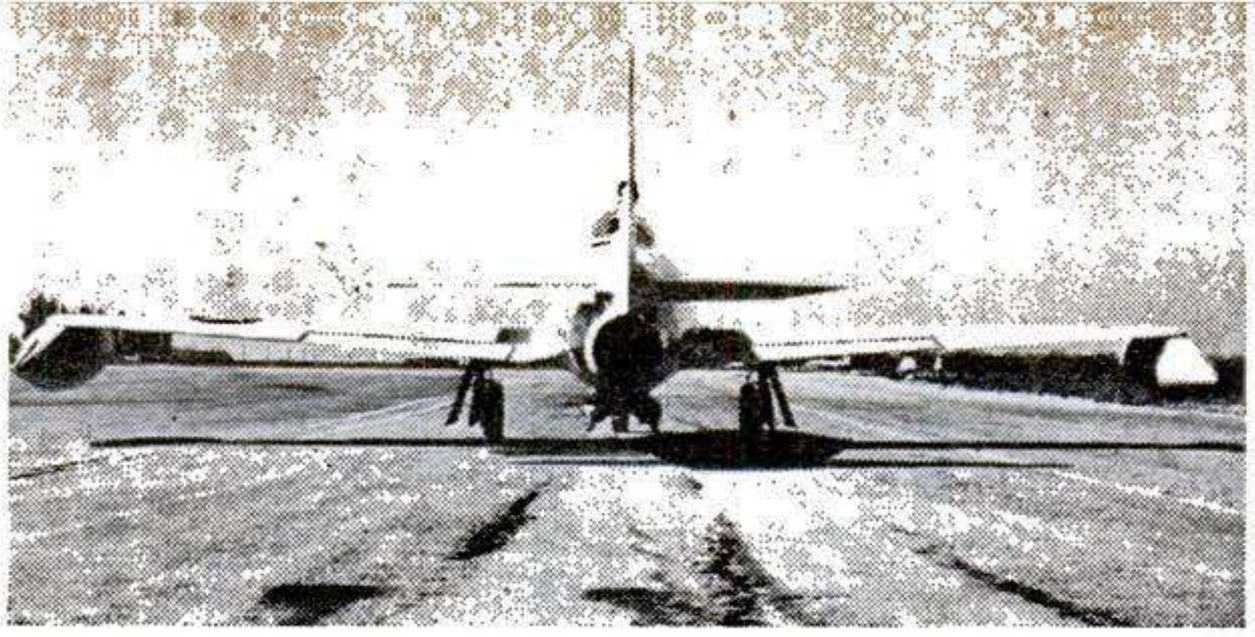
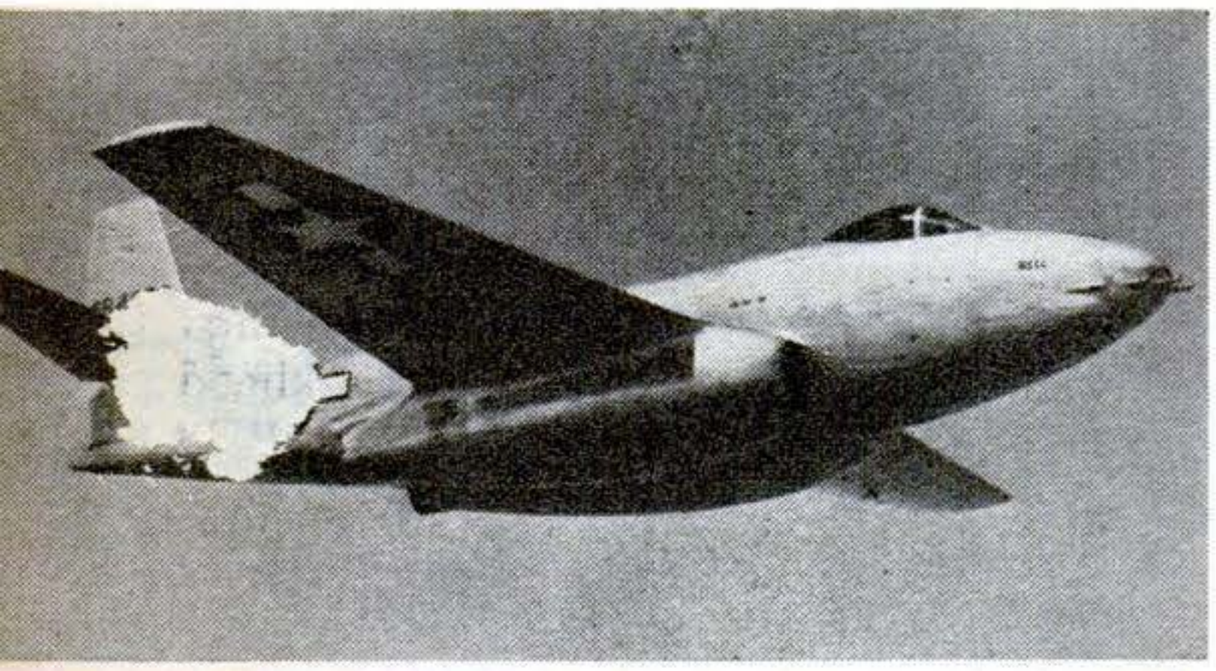


P-79 FIGHTER—This flying wing has a span of 38 feet and twin fins mounted atop the wing. The rudder-assist ducts aid in operating split flap rudders at the wing tips. Pilot lies prone in flight.



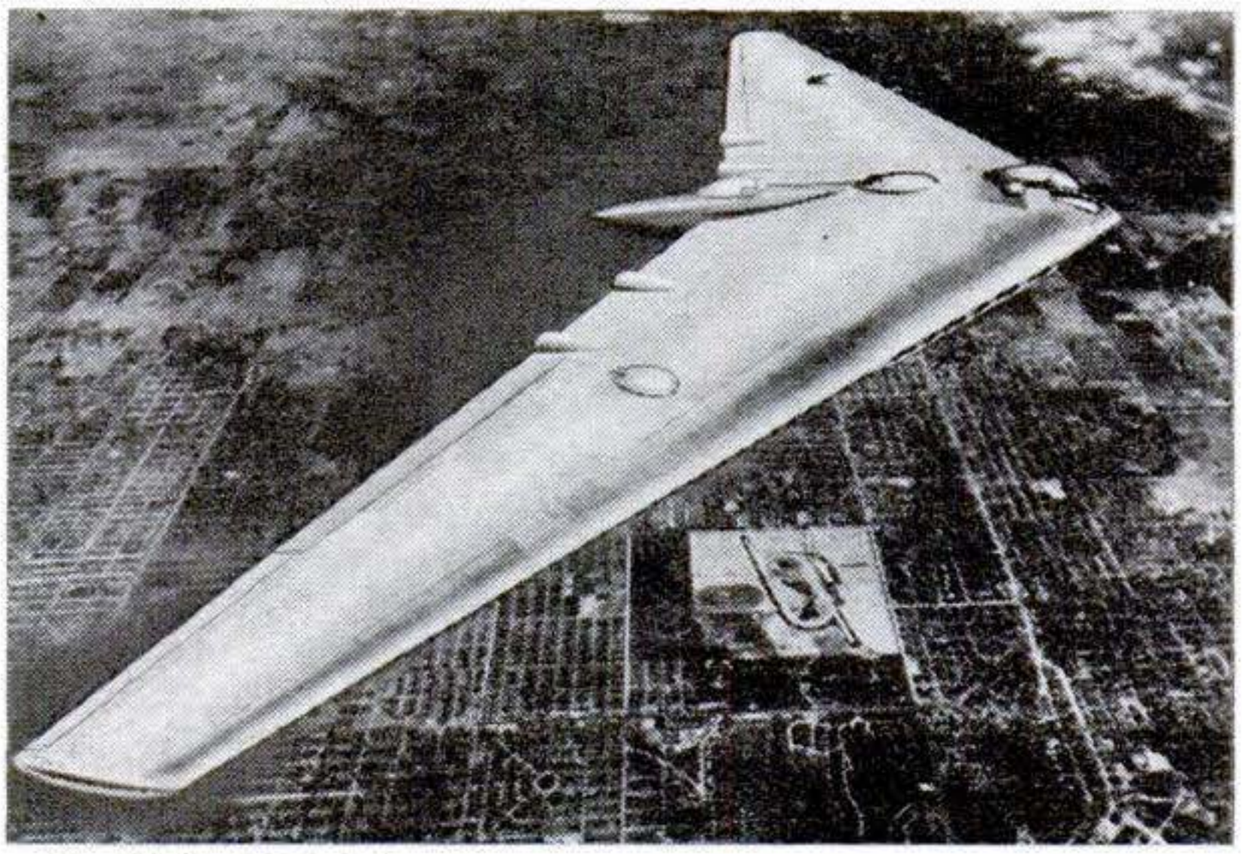
P-80 FIGHTER—This transcontinental record-breaker is the current backbone of the jet air force. Span is 38 feet. Two 175-gallon wing-tip fuel tanks give ship 700-gallon capacity, 2,000-mile range.



P-83 FIGHTER—Twin jets just outboard of the lower fuselage drive this 27,000-pound long-range fighter. Wing span is 53 feet. Rated at 550 m.p.h., its ceiling is 40,000 feet.

P-84 FIGHTER—Powered by an axial-flow unit with the air scoop in the nose, this 9,000-pound craft is expected to become the AAF's primary interceptor. Wing span is 36 feet 5 inches.

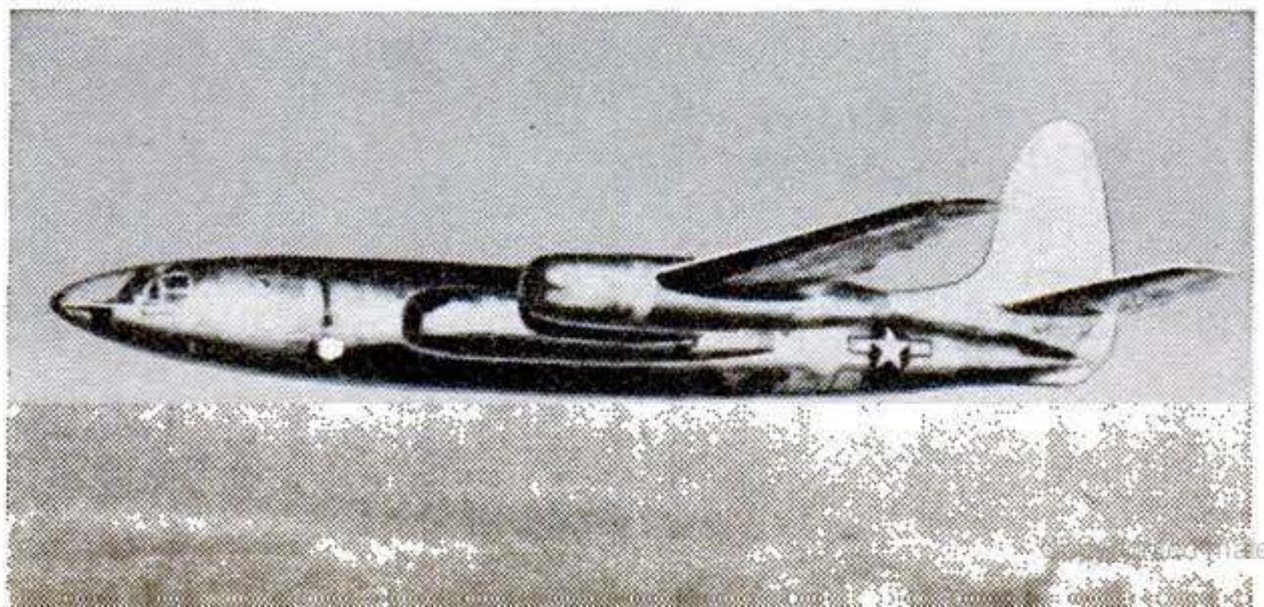
B-43 BOMBER—Two axial-flow engines provide 8,000 pounds of thrust through the twin tail pipes visible under the empennage. Wings spread 71 feet 2 inches; length is 51 feet 6 inches.

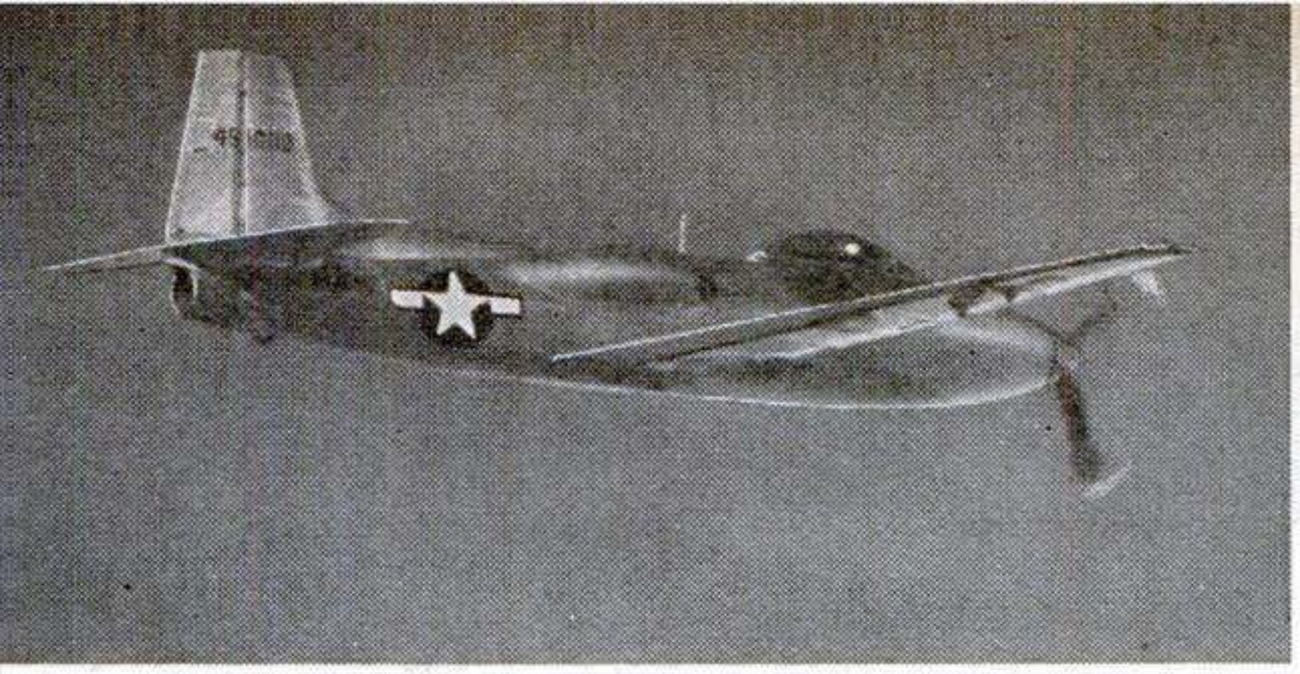


B-49 BOMBER—Designer's conception of jet version of B-35 Flying Wing. With a span of 172 feet, this boomerang-shaped giant may fly 10,000 miles with a 60-ton bomb-and-fuel load.

B-36 BOMBER—This is how the monster 132-ton, six-engine long-range bomber will look when jet units are installed. Conventional model takes crew of 17. Length: 163 feet; wing span: 230 feet.

F-12 PHOTO-RECON—When jet engines replace its conventional power plant, this sleek giant is expected to become the jet air force reconnaissance ship. Present range is 4,100 miles.





P-81 FIGHTER—Gas turbine races prop, pure jet unit in rear of fuselage provides thrust for this speedy escort-fighter. Twin air scoops for jet plant are located topside midway on fuselage.

JET HELICOPTER—This jet 'copter was built by Gazda Engineering. AAF also is designing one. Jet engine cuts down torque, is used for turning, and gives a helicopter unusual speed.

P-87—Curtiss-Wright. All details restricted.

Bombers:

B-43—Douglas. Speed, 500 (plus) m.p.h. Ceiling 35,000 ft. Will be used for attack and medium bombing.

B-45—North American. Will be powered by multiple jet units.

B-46—Consolidated-Vultee. Powered by multiple jet units.

B-47—Boeing. Powered by multiple jet units.

B-48—Martin. Powered by multiple jet units.

B-49—Flying Wing, by Northrop. Range 10,000 miles with 60-ton bomb-fuel load as B-35 (conventional engines). This plane will have jet engines installed; will probably be used as long-range, high-speed heavy bomber. Speed figure is undisclosed, but is believed to be above 450 m.p.h.

B-36—Consolidated-Vultee. This six-engine bomber may have jet application.

The B-49 may be flying this year; the B-48 is expected to fly in 1947. The others are scheduled for 1948.

Photo-Reconnaissance:

F-12—Republic. This 400 m.p.h., four-engine plane is expected to receive jet engines and become the high-speed, long-range reconnaissance ship of the jet air force.

Helicopters:

A design study on a jet helicopter is now in progress.

Jet military transports are not being considered for the jet air force. The unstreamlined, boxcar shapes necessary to haul the requisite tremendous loads of supplies and troops could be propelled by jet only at great expense, because of the high fuel consumption. Conventional transports, which can meet the logistical demands of a military operation, can provide a "pipe line" constantly moving at nearly 400 m.p.h., fast enough to make the speed differential from jets unimportant.

Power Plants:

I-40—General Electric. Centrifugal-flow. Produces 4,000-lb. thrust, equivalent roughly to 5,000 horsepower. Weighs only 1,820 pounds; thus delivers 2½ horsepower per pound of weight, compared to one horsepower per pound by the reciprocating engine. Powers the P-80, the P-83, and provides part of the power for the P-81. Allison Division of General Motors also produces the I-40, has been since October 1945 the sole builder of P-80 power. Allison is now building a model of the I-40 incorporating many improvements, devised by its own engineering staff, which are expected to add to the P-80's speed.

TG-100—General Electric. Axial-flow. Helps power P-81.

TG-180—General Electric. Axial-flow. Produces 4,000-lb. (plus) thrust. Powers P-84, helps power P-81, powers B-43 with two units.

19-B—Westinghouse. Produces 1,365-lb. thrust. Two units power P-79.

Many other jet-power applications are being made. Rocket engines will probably be used in short-range interceptors. They will certainly be used for assisted take-offs and as auxiliary power plants to provide extra bursts of speed when needed. One of the most interesting uses of rocket power is expected to come with parasitic-fighter flight. The AAF is experimenting with a tiny plane, the XS-1, built by Bell, which is taken to high altitudes for release. This plane is not yet powered, but rocket engines would make a plane built on its experience a fine weapon for interception flights, of short duration, from above.

The most recent jet engine—the ramjet—offers limitless possibilities. Dubbed the "Flying Stovepipe" because in crude terms

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RAMJET ENGINE—Zooming from its ground-launching platform, this "flying stovepipe" has sped up to 1,500 m.p.h. and gives promise of becoming the power plant to propel aircraft at supersonic speeds.

it is a stovepipe with a fire in it, it has no moving parts and consequently no lubrication system. Driving through the air at extremely high speeds, it provides its own intake and compression of air. Combustion heats the air, and power is derived from the air's expansion and escape.

Ramjet appears to be the most suitable engine to defeat the high-fuel rates of supersonic flight. Obviously, it can not have effective power at low speeds, but ramjets can be attached to wings of planes that will approach speed of sound by other available power means. Then the ramjets can be turned on to break through the sonic barrier.

This tiny ramjet engine, weighing only 70 pounds, delivers more than 2,200 horsepower—one horsepower for each half-ounce of its weight. Speeds of from 800 to 1,500 m.p.h. are possible.

Training of personnel for the jet air force is well along, considering that this activity cannot begin until planes and engines have been finally proved acceptable. A pilot school at Williams Field, Chandler, Ariz., is turning out 50 pilots every seven and a half weeks. The first class graduated two weeks ago.

The eligibility requirements are stiff, but not because jets are hard to fly. The prospective jet pilot must hold a commission in the regular Army or have applied for one. He must agree to remain in the AAF indefinitely. He must have had 500 military flying hours in World War II, 150 of these in fighter planes, and 25 hours in fighters in the six months immediately preceding his training at Williams. (Only fighter pilots are being trained until jet bombers become available.) In his training, he flies P-80s for 30 hours and goes to ground school.

One fighter group already has been activated, the 412th, under command of Col. Bruce K. Holloway. It is stationed at March Field, Riverside, Calif., and comprises the 29th, 31st and 445th Fighter Squadrons, the 39th Tactical Reconnaissance Squadron, and the 361st Fighter Service Group.

Training of mechanical personnel for jet planes began at Chanute Field, Rantoul, Ill., in the spring of 1945. There, personnel receive a six to seven weeks' course in structures, hydraulics, power plants, instruments, electrical systems, etc.

Shaping of an air force that will travel reasonably soon at speeds near that of sound posed, in addition to mechanical problems, many physical obstacles. Hurtling the human body through space at 600 m.p.h. and better is impossible, without fatal consequences, unless protective devices are available. These have been developed.

Simplicity of jet-plane construction carries many advantages. A jet engine can be changed in 30 minutes, a job that used to take hours or days with piston engines. Unique problems are being confronted, however, as is natural in development of any revolutionary item. One of these has to do with plane instruments. As sonic speeds are approached, compressibility upsets the functioning of some instruments. The problem of controls freezing at high speeds has introduced the possibility that lateral maneuvering of jet aircraft in future may be done by rocket charges or auxiliary jets attached to the wings.

AAF production experts who are working with the aviation industry in building the first jet air force do not have the harassed mien of their kind. They are confident, unworried.

"They're easy to build," they say.

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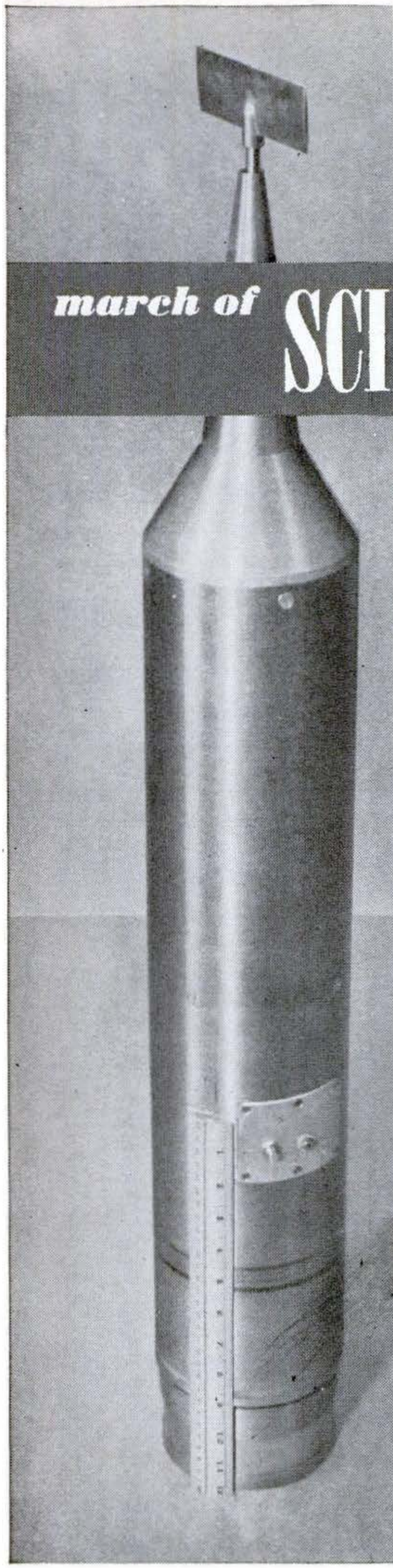

march of SCIENCE

Microwave "Searchlight." In the world's first commercial radiophone system using ultra-high-frequency microwaves, these antennas and parabolic reflectors atop the Telephone Building in Los Angeles beam voice messages at a 30-foot tower erected on a Santa Catalina Island peak, 30 miles away, and receive replies. The ultra-high-frequency beam, concentrated within a narrow band and aimed like a searchlight, pulsates 1,000,000 times a second. The modulated microwaves assure static-free conversation and security, since only similar apparatus can detect the signals. Messages from Catalina are received in Los Angeles and relayed over telephone lines to points throughout the United States.

Rocket Tests Airfoils. Tiny wing sections, or airfoils, are now tested at supersonic speeds as they ride on rods in the noses of "Holy Moses" rockets, four feet long and five inches in diameter. Developed by the Jet Propulsion Laboratory, California Institute of Technology, the Rocket Air Foil Tester (RAFT) is testing materials for both piloted and pilotless guided missiles until superspeed wind tunnels are designed and built for the job. As the rocket races through the sky, magnetic-strain gauges measure the pressures produced by aerodynamic forces, and results are radioed automatically from a self-contained transmitter to a ground station. The rocket shell casing itself acts as an antenna slightly less than a half wave length long.

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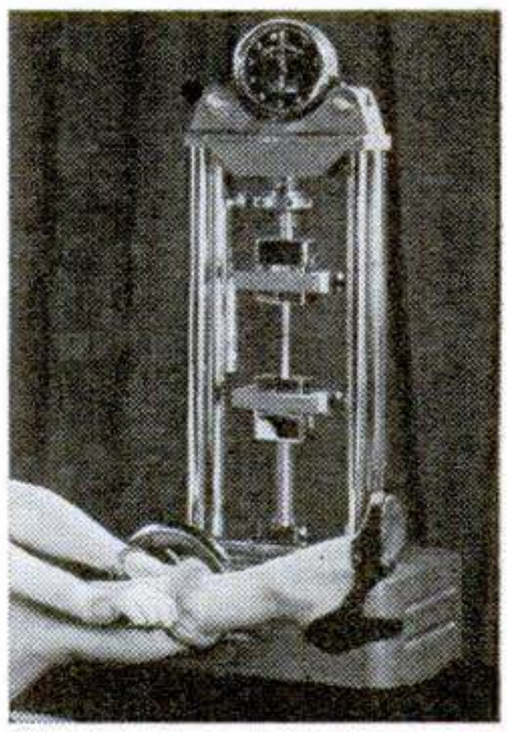
Loudspeaker for Individual Carries Voice 1,000 Feet

A SERGEANT wearing the latest model voice amplifier developed by the Army Signal Corps can now be heard for 1,000 feet when he yells, "Aw right, you guys, dress that line!" The new individual loudspeaker is more rugged, is powered by a storage battery instead of a dry cell, and weighs only three pounds.

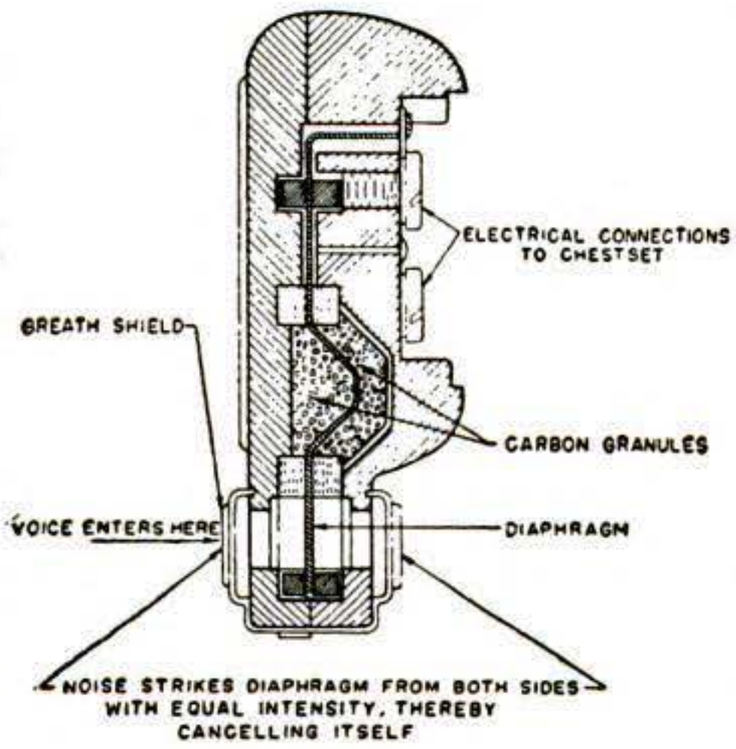
Miniature Oil Furnace Heats Five-Room House

ABOUT the size of a refrigerator, the new oil-burning heater made by General Bronze Corp. will deliver forced warm air to all corners of a five-room house in about three minutes after the thermostat has been adjusted. The miniature furnace has a traylike air filter and an automatically controlled humidifier.

Machine Tests Tensile Strength of Both Stockings and Steel

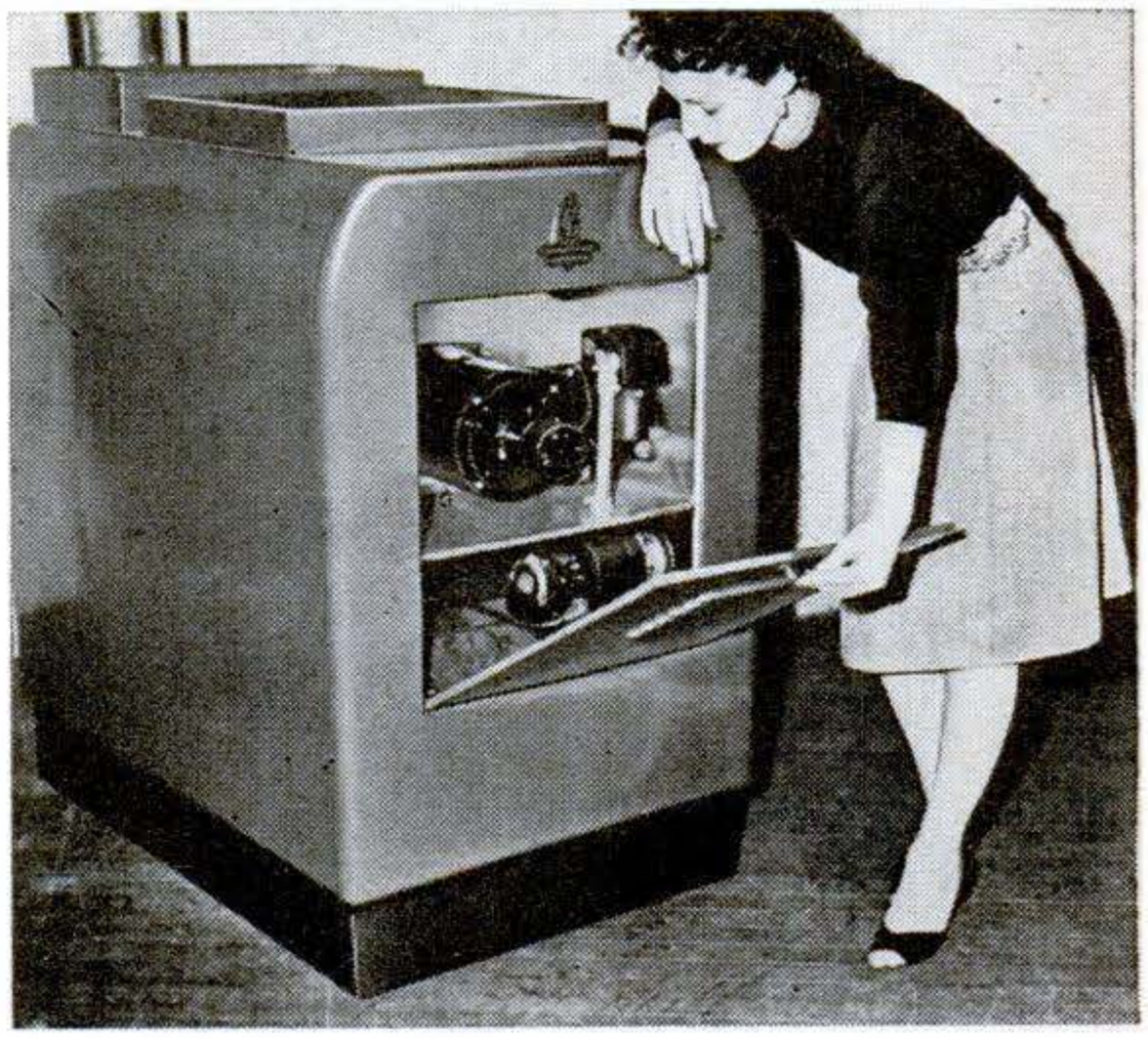


A COMPACT, portable machine for testing the tensile strength or the compression of a variety of materials ranging from nylon stockings to steel castings has been produced by W. C. Dillon & Co., Inc., of Chicago. The new machine, first of its kind, accommodates loads weighing from 250 to 10,000 pounds.



Lip Mike Cancels Outside Noises

THIS Signal Corps microphone, worn on the upper lip, makes wire, radio or interphone communication possible in a din. Outside noise enters small holes at the front and back of the diaphragm in equal volume, thereby canceling itself.



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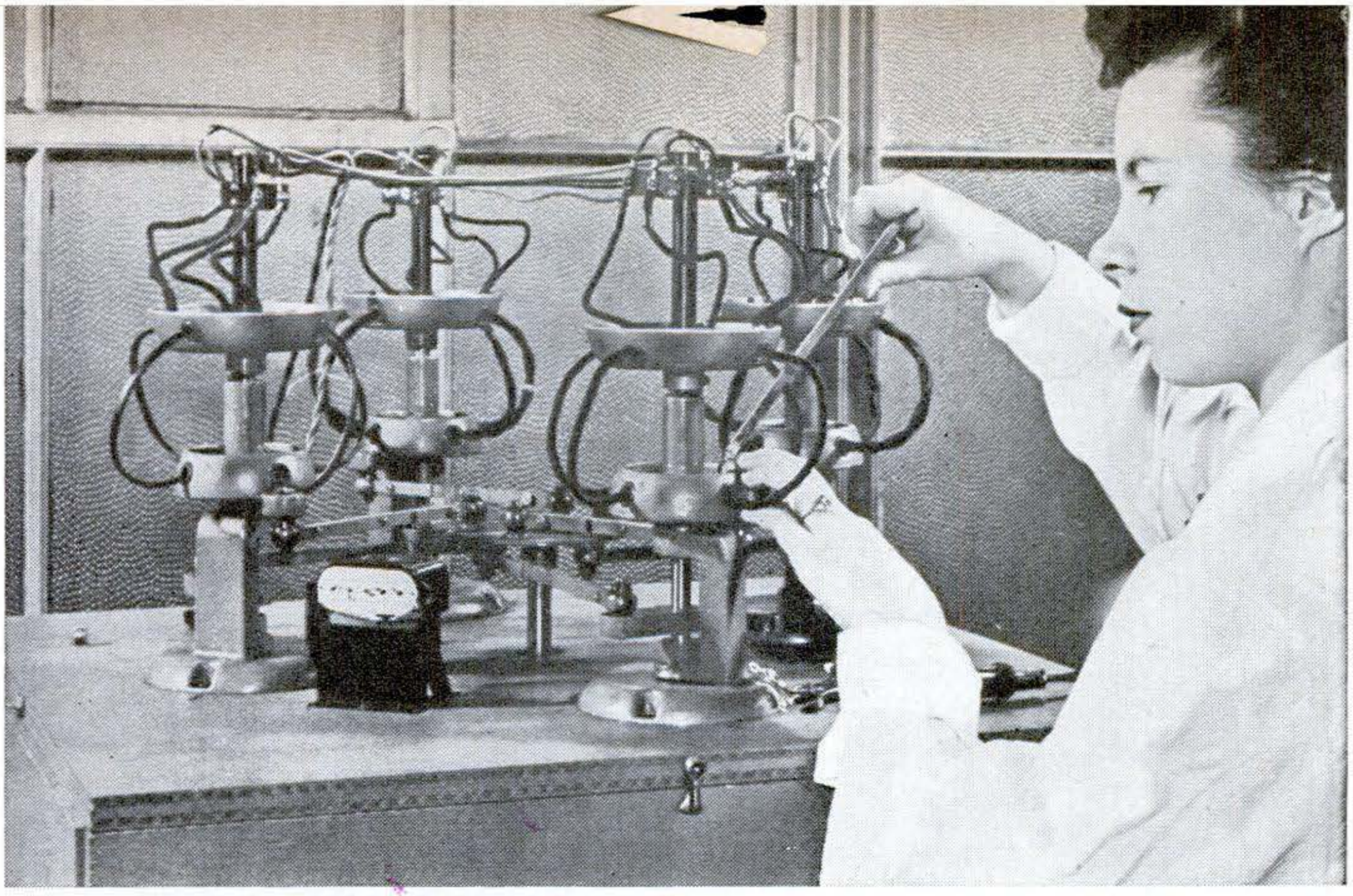
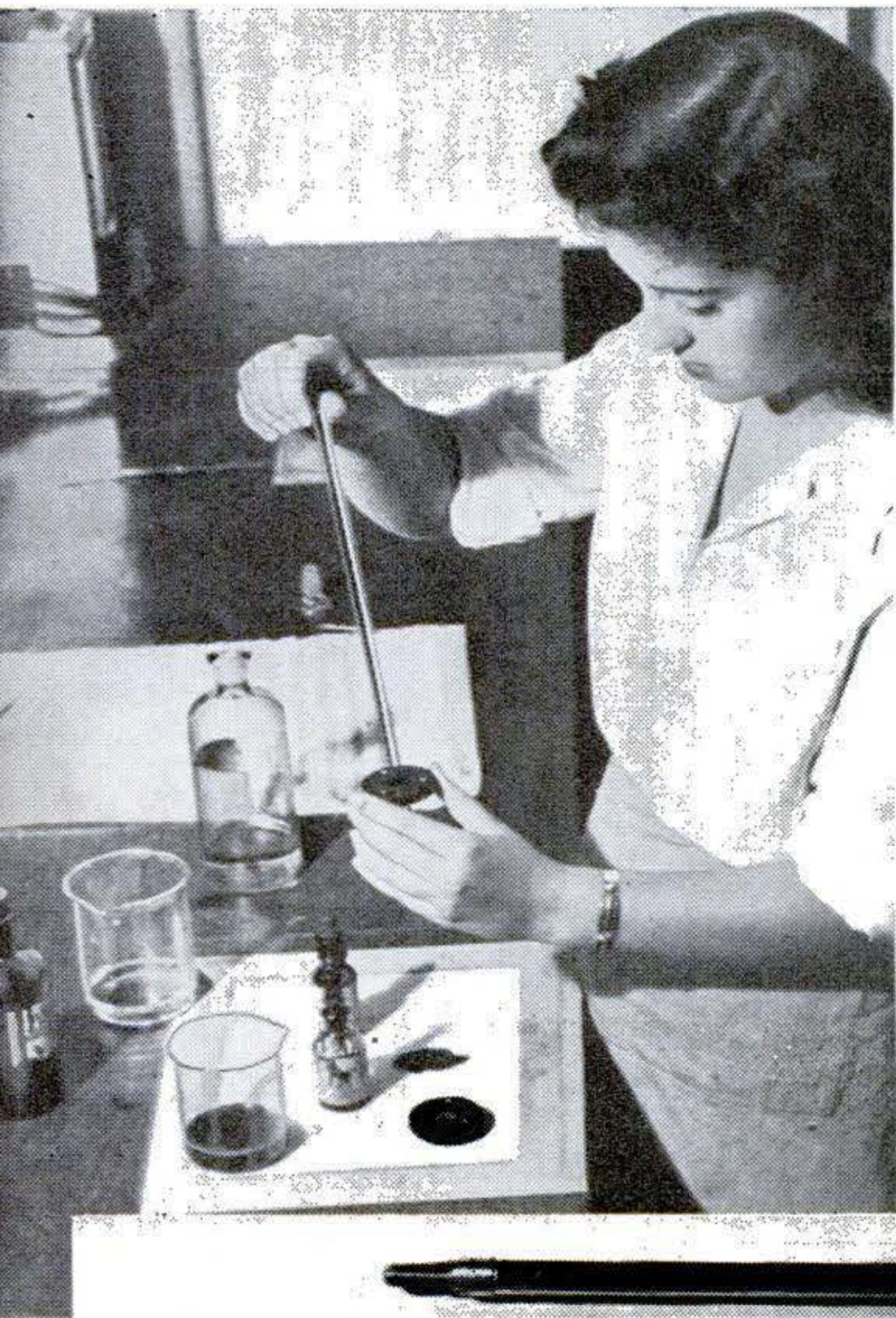
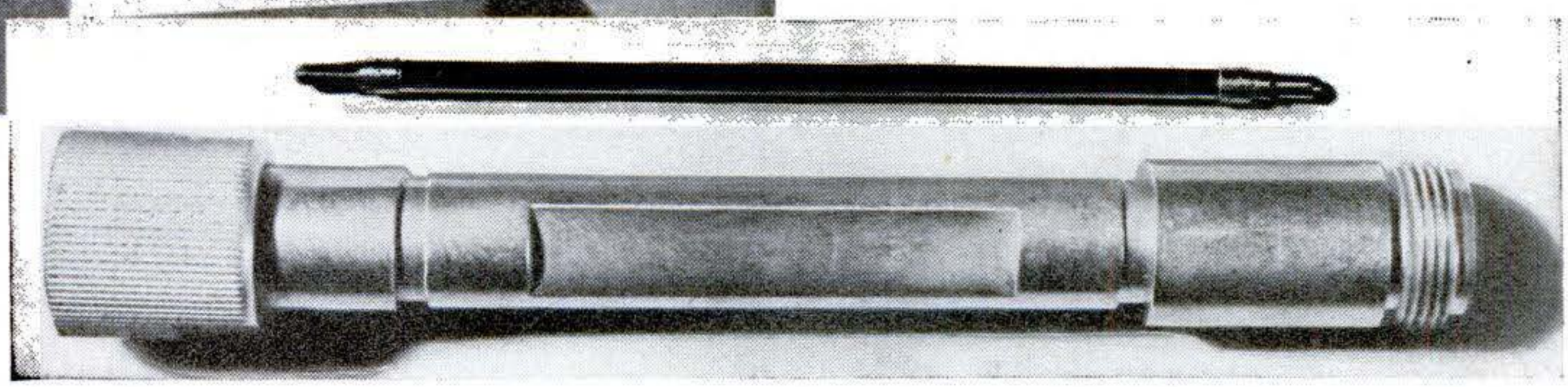




"Hula," the Cord Twister. Electric cords for household appliances are tougher and last longer because of "Hula" (above), a robot cord twist tester devised by Westinghouse Electric Corp. Nicknamed because its twisting cords resemble the swaying of a Hawaiian dancer's skirt, the machine tests 16 samples at one time. Its four postlike shafts each have two metal rings through which foot-long sections of cord are threaded. One ring is pushed 90 degrees clockwise at the same time that the other is being pulled 90 degrees in the other direction by eccentric arms connected to the vertical shaft in the center of the cabinet.

Checks Radar Range. The all-seeing eyes of radar might have been shortsighted in vital wartime operations except for the metal-coated, glass-rod attenuator shown below with its metal casing. Developed by the Polytechnic Institute of Brooklyn, N. Y., this key instrument reduces the microwave power sent out in radar beams by an exact known amount—to a value that can be measured with portable test equipment. Comparison of the measured output of the set with its rated power then indicates whether or not its beam is completely covering the specified area. New techniques of metallizing glass had to be devised—one step of which is shown by the technician at the left—so that the glass rods would take on a coating of metal film only a few millionths of a centimeter thick.



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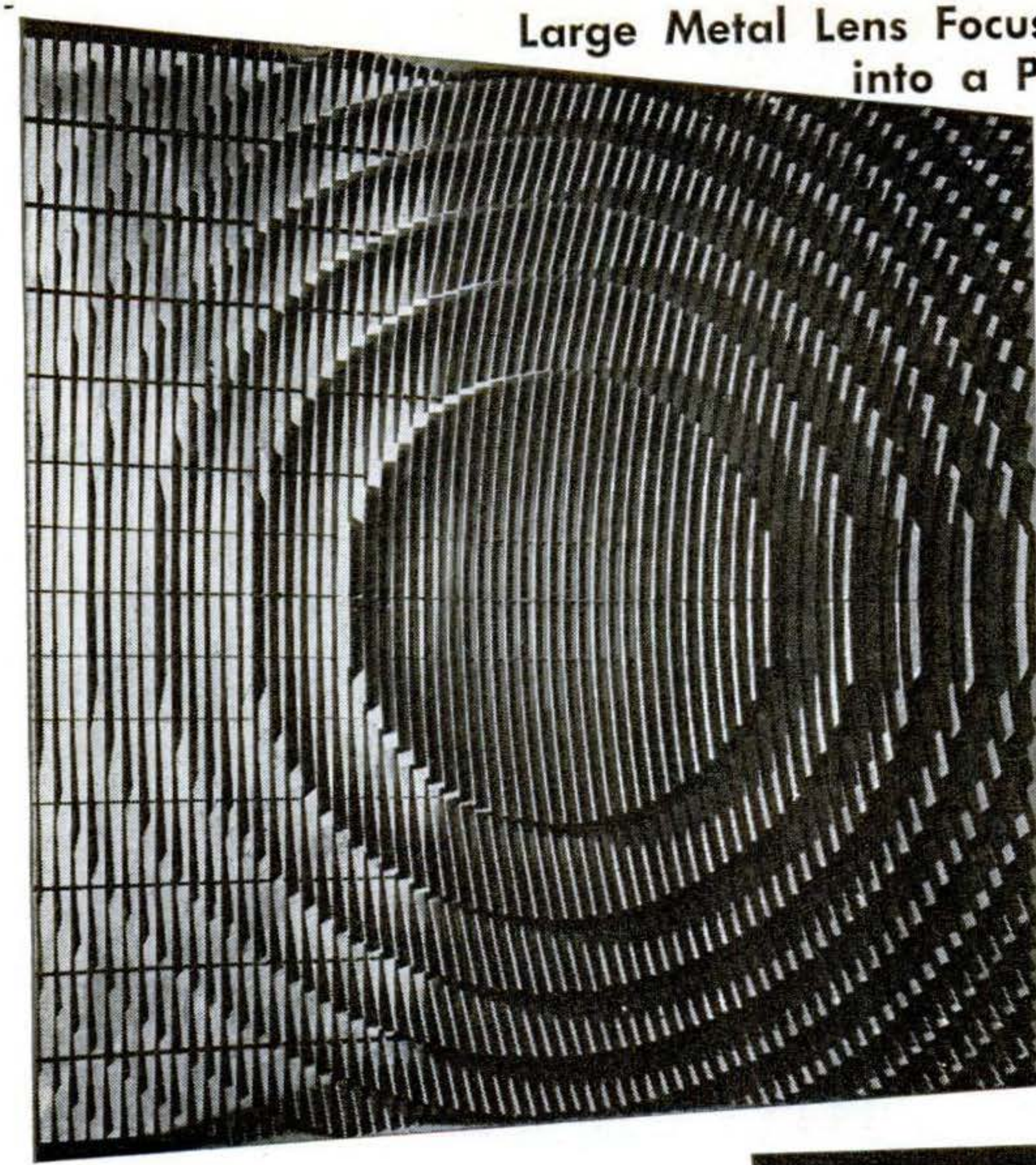
Large Metal Lens Focuses Radio Waves into a Pencil-point Beam



MUCH as a glass lens focuses light, this 10-foot-square metal lens, designed by Dr. Winston E. Kock, of Bell Telephone Laboratories, converges radio waves into the sharpest beam of its kind. Metal plates duplicate the action of convex and concave lenses and other optical devices. The new lens was made for microwave radio-relay systems, to supplement the telephone network, but it is also a promising device for radar navigation. It operates at 5,000,000,000 cycles a second, with a wave hardly as long as a cigarette.

Pool Cleaner's Diving Mask

A LIGHT diving mask of molded rubber for use in cleaning pools has been developed by the Diving Equipment and Supply Co., Milwaukee, Wis., makers of deep-sea diving suits. The mask, shown below, has a shatterproof, transparent plastic face piece, which is pressure sealed. The user can adjust the flow of air to suit himself.

Combination Knife-Fork Makes One-Armed Eating Easier

EATING with one hand has been made simpler by an invention of Edward A. Towlen, of Detroit, who lost the fingers of his right hand 32 years ago. In one stainless-steel utensil he has combined the cutting blade of a knife and the tines of a fork; useful, he thinks, for crippled veterans. The device has a leather case, to permit the user to carry it to meals away from home.

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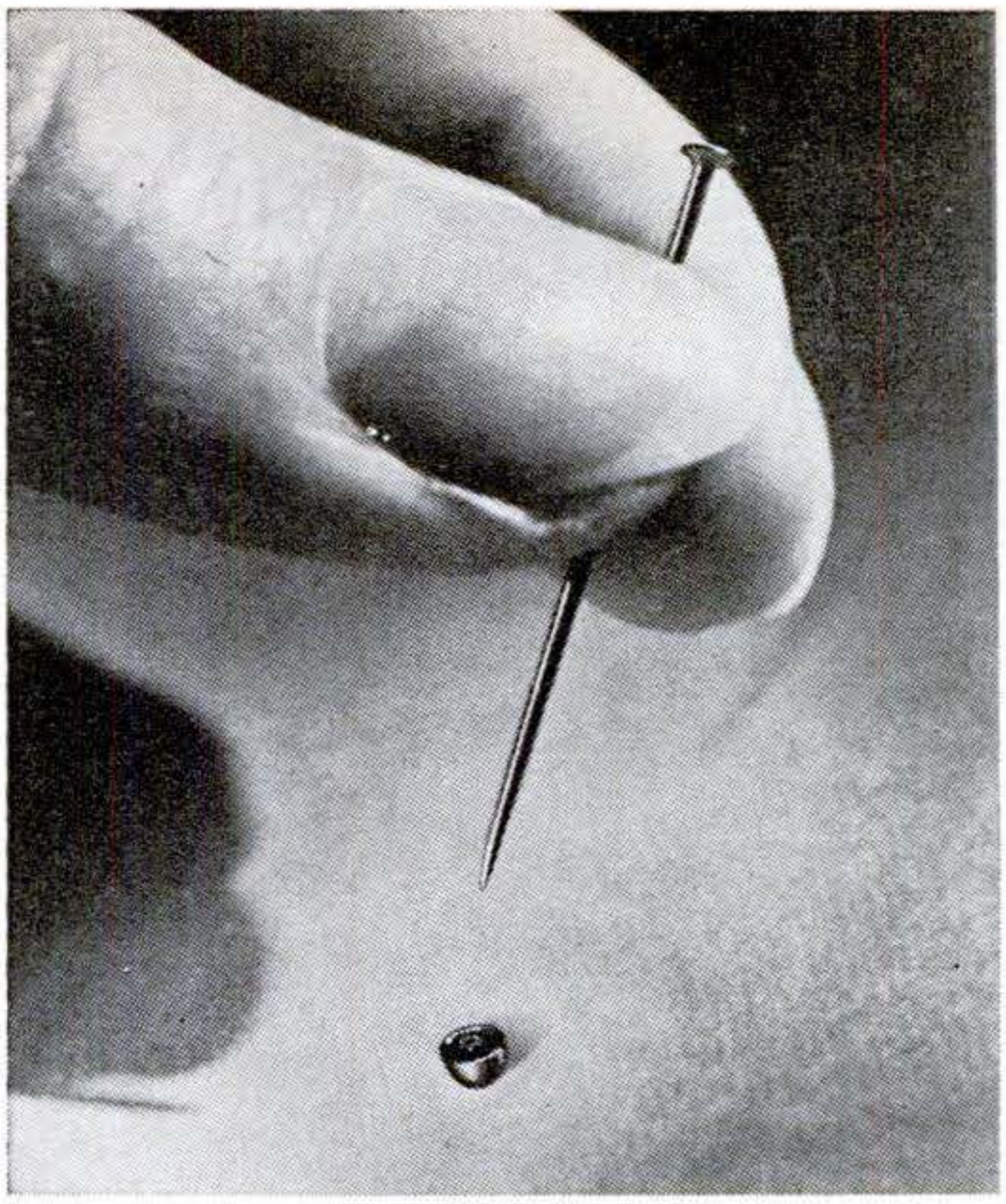
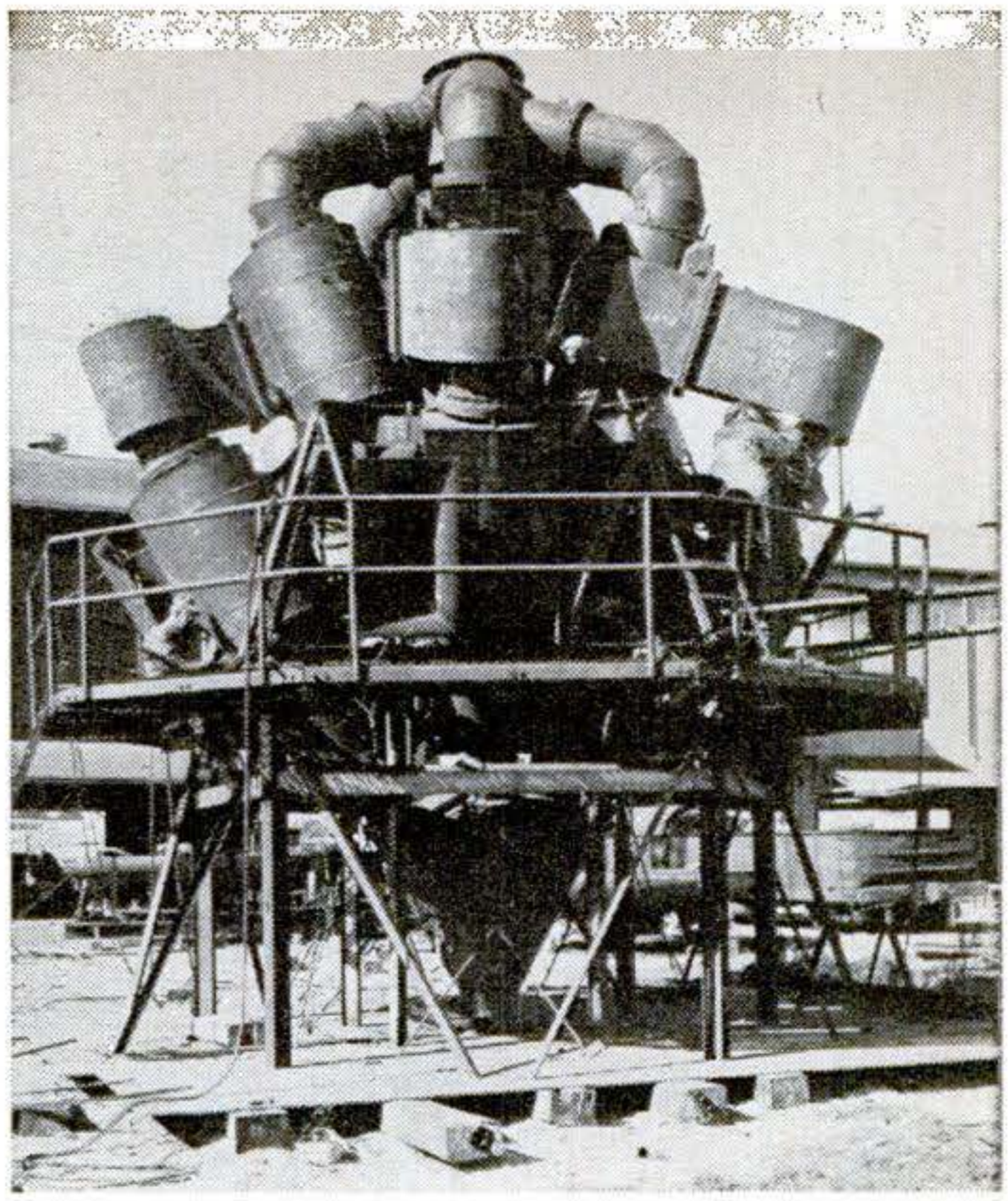
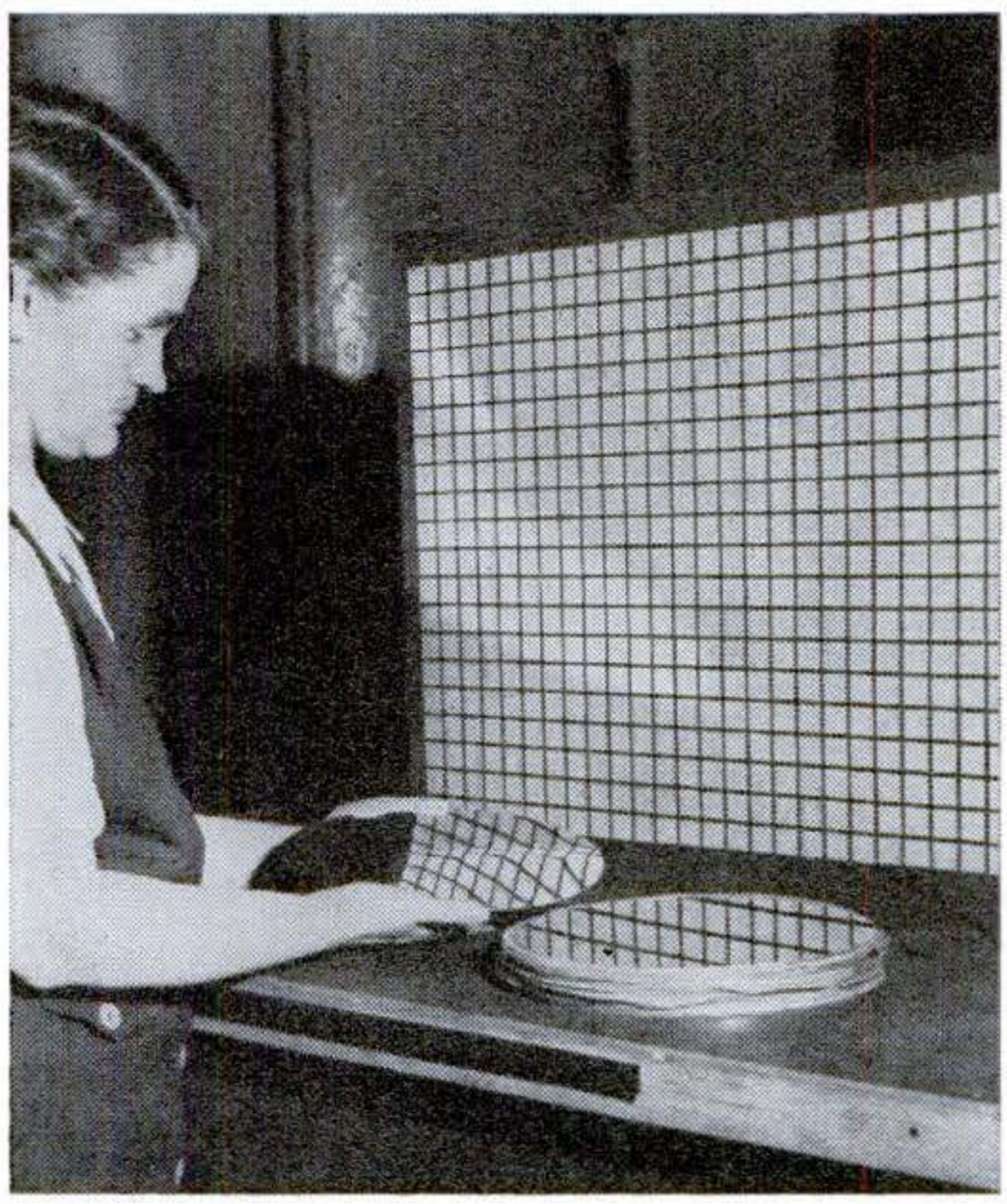


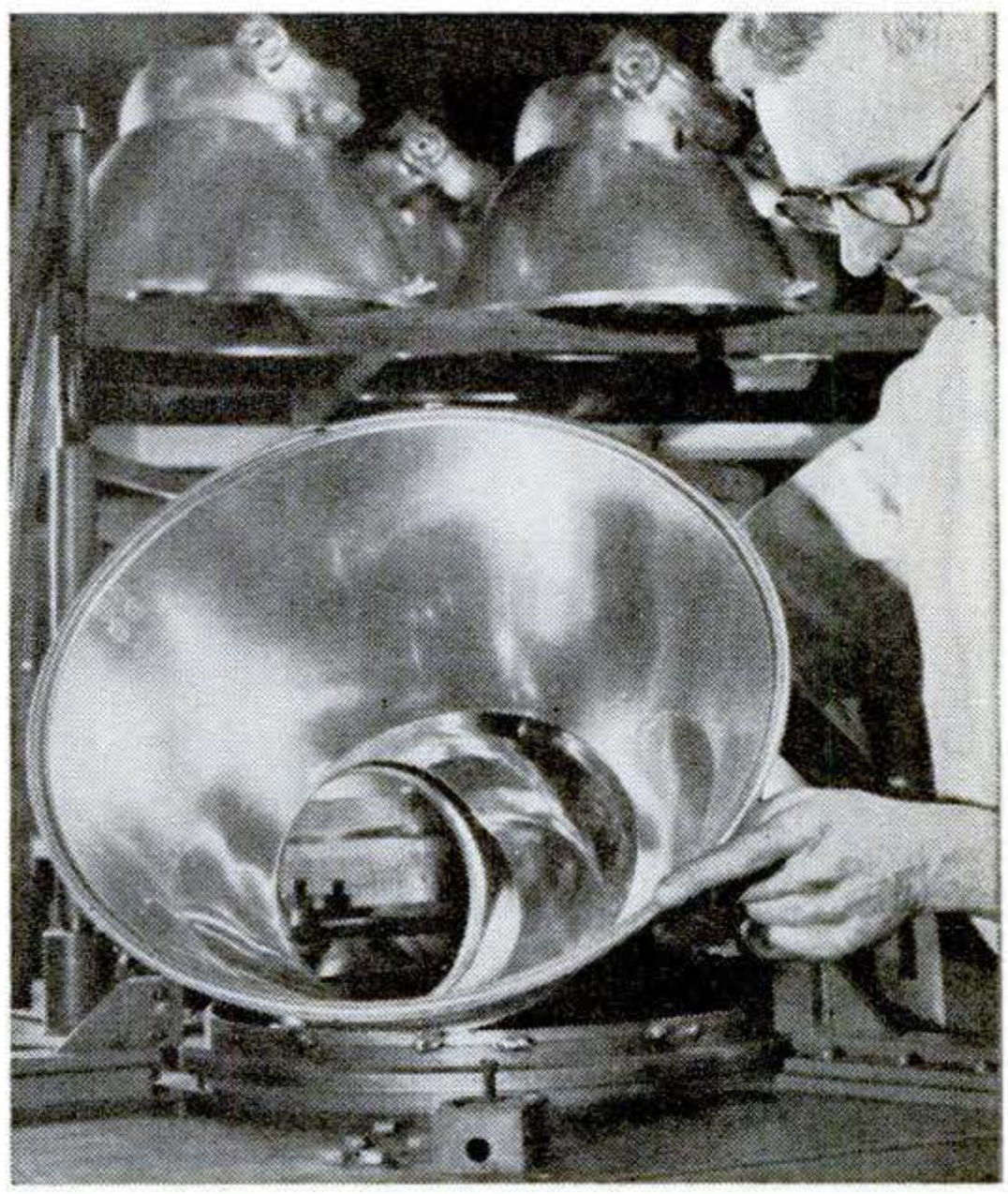
Smallest Ball Bearing. The pin points toward three tiny steel balls in a jacket. Each ball is only 1/25-inch thick and precisioned to a tolerance of 1/25,000,000 inch—the tiniest in the world. Millions were used in atom-bomb test devices.



Cyclone Separator. Not meteorological equipment, or a rocket launcher, this device removes and recovers catalysts from the outgoing vapors of the reactor of the new catalytic cracking unit of Shell Oil Co.'s refinery, Houston, Tex. It weighs 29 tons.



Dimple Detector. This ruled board by reflection instantly shows up defects in master recording disks that formerly were a headache to find. Developed by Audio Devices, New York, it plainly shows distortions in the surface of the disk.



Glass Spun onto Floodlight. Designed for use at night baseball games, this light has been proofed against weather, dirt and insects by spinning the front glass onto the aluminum reflector with special tools. Maintenance is from the rear.

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Our Forefathers GROUND THEIR OWN

American colonists pounded corn for hominy in a hollowed log, an adaptation of Indians' stone pestle and mortar (lower left). Quern (lower right) was hand-operated, two-stone mill that ground grain fed into opening.

The next step in the milling of grain was a quern whose two stones could be adjusted to coarse or fine grinding by regulating the space between them. This one came from a North Carolina plantation.

Animal power was added when man devised the single millstone. An ox or horse was hitched to the outer end (right) of the shaft, which was fastened to a pivoted upright, and turned the wheel in a trough.

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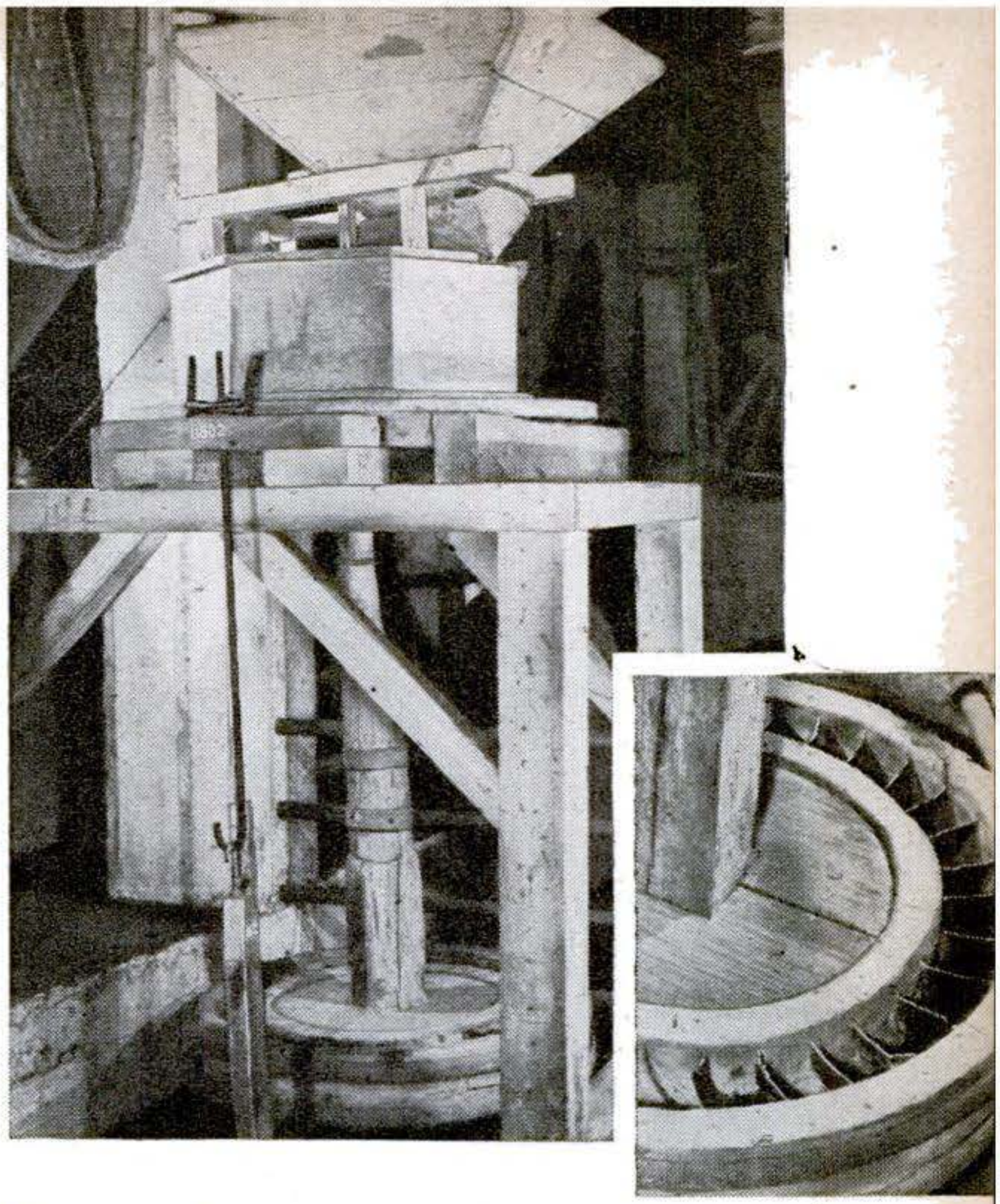
The history of flour is the oldest chapter in the history of mechanics.

PSM Photos by HUBERT LUCKETT



The *force* of water—not its *weight*—was next harnessed. A swift downflow against fins of the wheel (see close-up) turned upper millstone upon the lower. Grain was fed through the hopper at top.

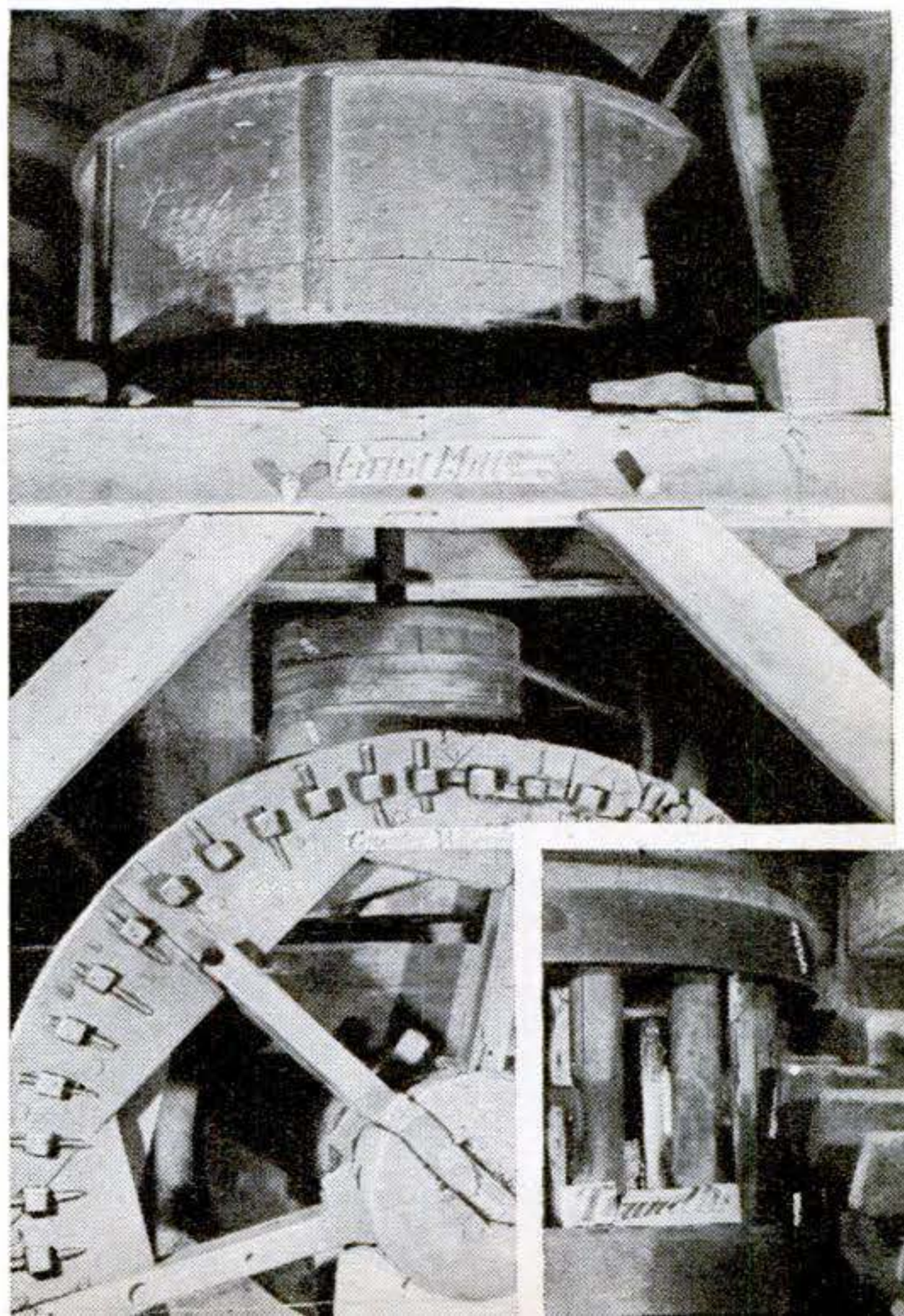
BREAD—from the standing grain to the steaming loaf—has always been an intimate part of living. Since primitive times, much ingenuity has been lavished on the grinding of grain. Possibly the first application of mechanical power was to the making of flour. Yet the principles have changed little since man first used millstones.

For a flashback to the old days and devices, PSM takes you to the Mercer Museum of the Bucks County Historical Society at Doylestown, Pa. There can be traced the history of flour making, which is also the history of mechanics.

There are rough stone mortars and pestles, used by American Indians; hollowed logs for pounding corn into meal; crude querns—early type of millstones—cranked by hand.

First came the simple machines that eased the strain on men's muscles. Then, as men used their heads to save their backs, came animal power and water power. The final step to the huge flour factories of modern times was far shorter than the long step from handmade meal to early power milling shown on these pages.

This counter-wheel and trundle are an early wooden version of the modern ring gear and pinion. A water-wheel turns the counter-wheel whose teeth fit between spokes of the trundle as seen in inset below.



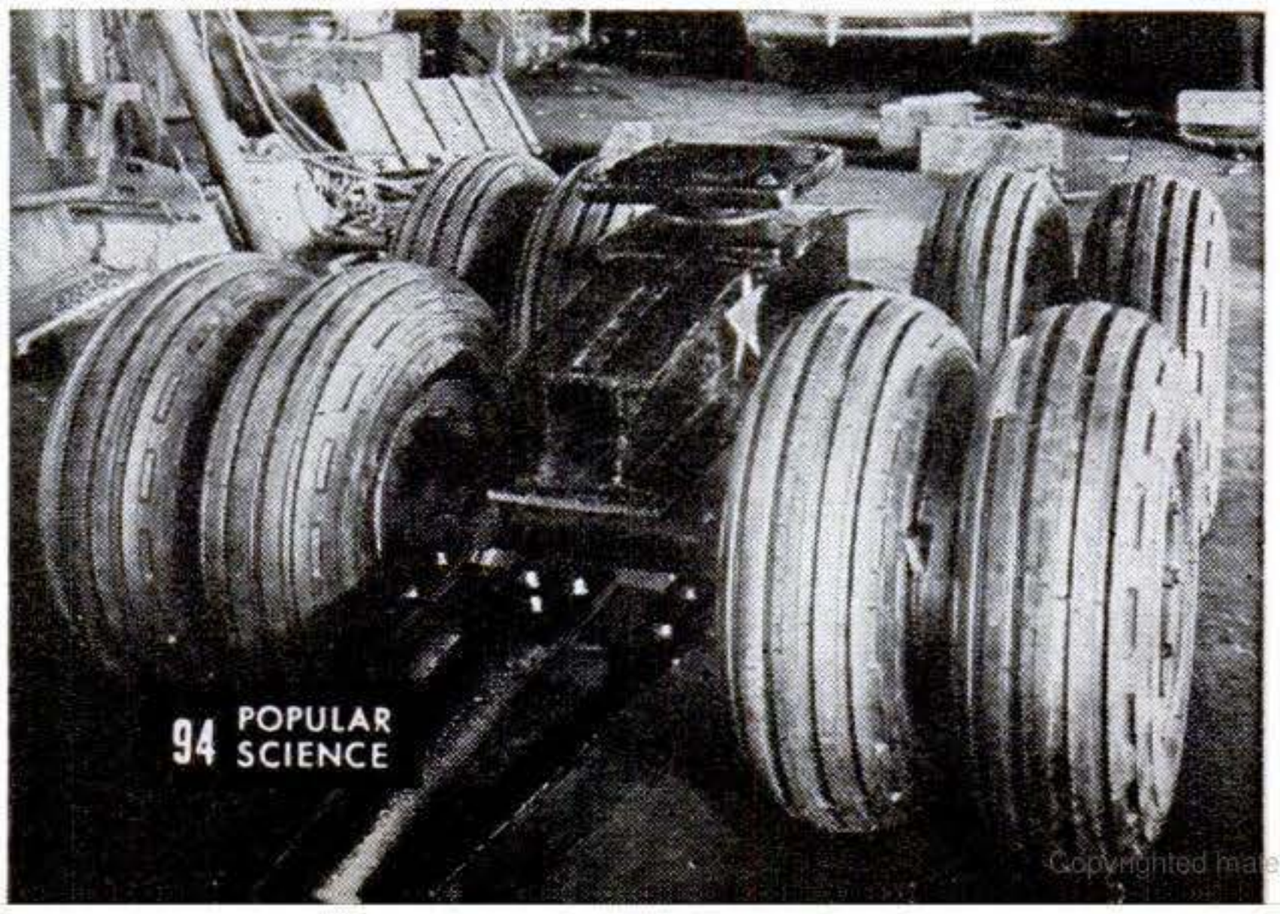
World's LARGEST AIRPLANE Takes to the Road

HERCULES, GIANT FLYING BOAT, MOVES PIECEMEAL TO THE SEA

Riding on low-slung house-moving dollies, the 60-ton hull of Howard Hughes's eight-engine plywood craft is shown on its way from the Culver City, Calif., plant, where it was built, to the Terminal Island graving dock where it will be assembled. The hull was supported on a steel cradle, which in turn rested on massive girders of Douglas fir. Towering 36½ feet above the highway, its bulk required 23 utilities companies to raise telephone and power lines in the seven towns through which it passed on its 28-mile trip.

Rear dollies (below) under one of the two 160-foot wing sections. Interconnection between the dollies permitted steering the rear end of the load by block and tackle to follow highway curves.

Close-up of one of the dollies (below). The special 16-ply tires are only 24 inches high, but those on rear dollies support 6,000 pounds each, those on front dollies, 8,000 pounds. Thirty-two tires were used under rear of the hull. All tires were partly deflated to cushion loads.



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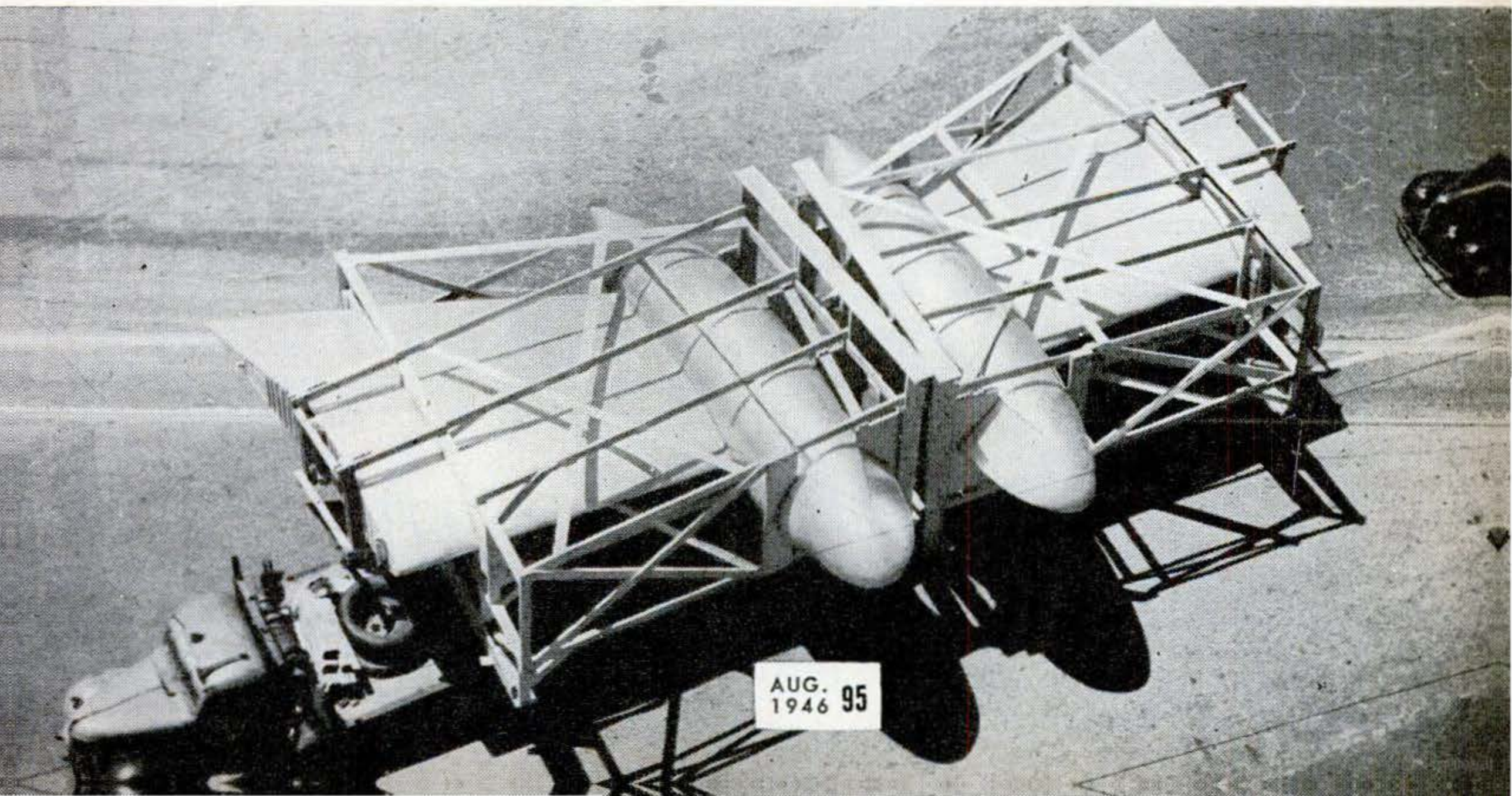
Turning corners, as shown below, emphasized the value of steerable rear dollies. Men walking beside the load were able to guide the rear end in the same way the rear end of a long hook-and-ladder fire engine is steered. The wings are nearly 50 feet wide at the inboard nacelles.

Towing the two wing sections across pontoon bridge (above) to reach Terminal Island was one of the most ticklish parts of the moving job. At one point in the crossing, clearance at the rails was less than one inch. It took two days to move the wings, which preceded the hull on the journey. Like the hull, the wing sections were carried on steel cradles, and were supported near the inboard and outboard engine positions. One truck towed each of the major units of the $20,000,000 sky giant.

Five major components of the airplane—its hull, two wing sections, ailerons and tail assembly—were towed on the sturdy dollies, but smaller parts, such as the wing floats (below), were loaded directly on trucks for the trip. The piecemeal method of moving and the route to be followed were decided upon after engineers had devoted two years to surveying possible ways of making the transfer.



They Missed the Slipstream. Forty-two fully equipped paratroopers spill out the rear of a Fairchild C-82 Army cargo plane without having to combat, for the first time, the slipstream from the propellers. The door of the C-82, which holds 12 to 18 more jumpers than the C-46 and C-47, respectively, opens at such an angle that the slipstream misses the men entirely. These combat veterans are from the "Gypsy Battalion" of the Airborne School, Ft. Benning, Ga., and are commanded by Brig. Gen. William Miley, a seasoned jumper.

Culver Model V. Inside the cockpit (left) of the Culver V (opposite page) is revealed the Mooney Simpli-Fly Control, which makes flying easy and safer by automatically trimming the ship for its most efficient performance at each flight attitude. Once the 85-hp. plane is rolling down the runway, the pilot merely turns the wheel between the seats until the pointers on the flight dial (inset) are at "take-off," and the plane becomes airborne. Then the pilot turns the pointers to "climb;" gaining sufficient altitude, he sets the dial at "cruise." Landing is just as simple. Interconnected controls do the work.

PIN UP

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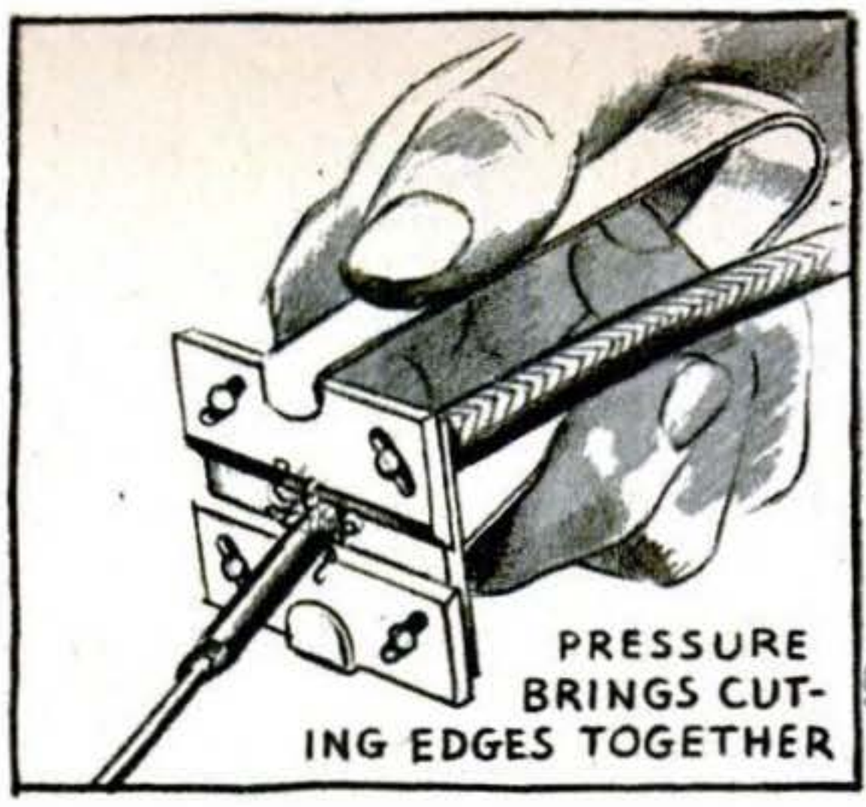
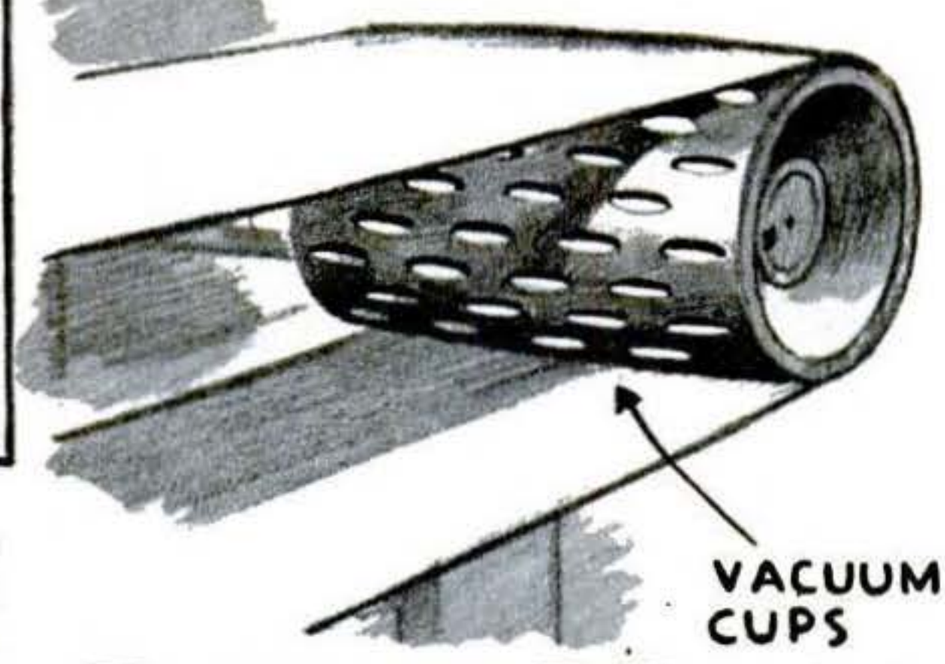
NEW IDEAS

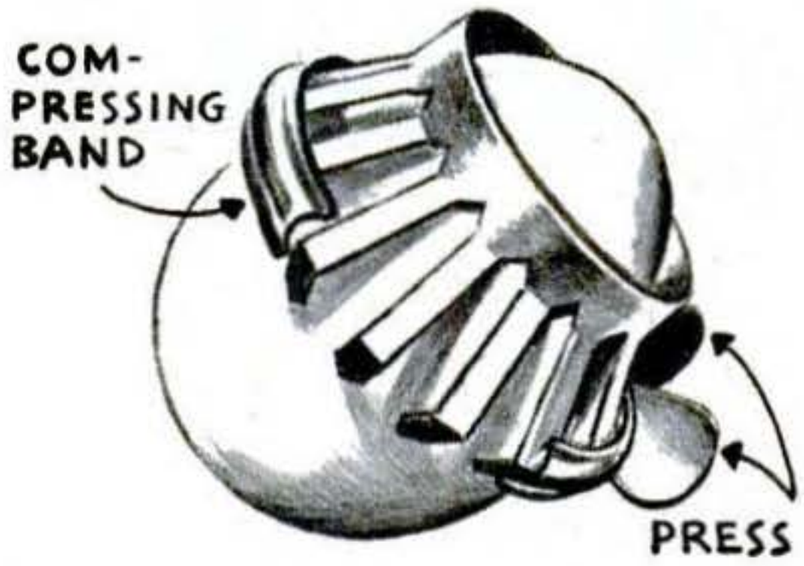


Insulation Stripper. Four cutting edges come together when you squeeze the spring-steel handle of this wire stripper. Upper and lower blades are welded to the handle; side cutters are moved by pins sliding in diagonal slots. Reuben Gordon, Jamaica, N. Y., invented it.

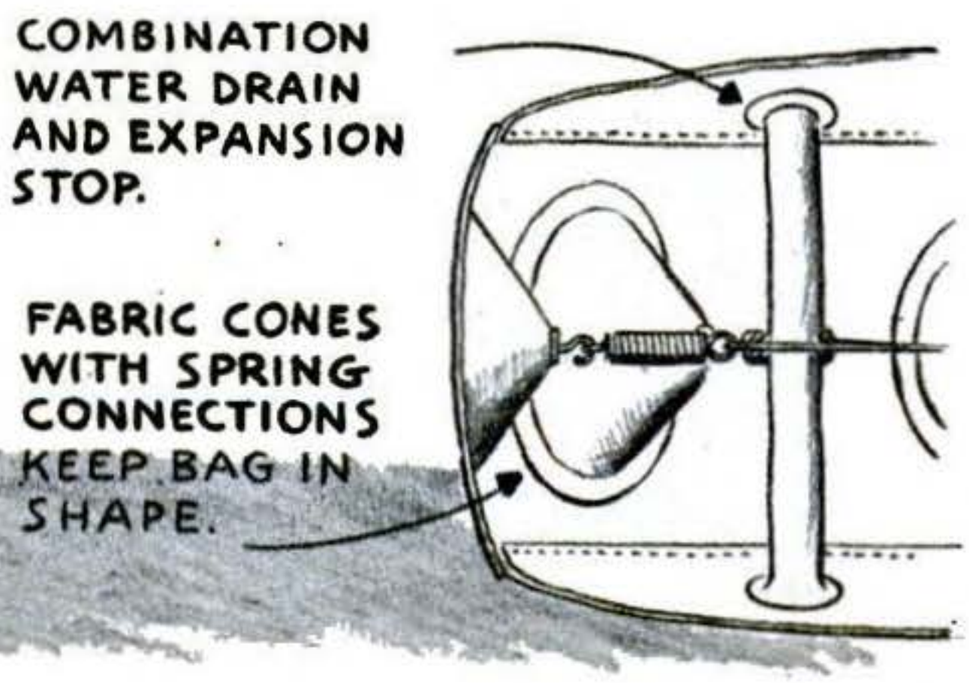


Vacuum-cup Pulley. An iron pulley, cast with shallow holes on the surface, resists belt slippage much as vacuum-cupped automobile tires tend to overcome skidding. Belt-driven farm machines have used the pulley successfully. Power loss is said to be negligible.

Egg Opening Made Easy. A safe and accurate means of opening either raw or boiled eggs is provided by an invention of John Mooss, Alhambra, Calif. Flexible prongs radiate from a collar that fits over the egg. The points bite into the shell with equal force when pressure is applied.



Giant Hassock for Fire Escape. This shock absorber for persons leaping from burning buildings is intended to be carried to the scene and inflated by fire-truck pumps. It is designed for sizes up to 40 feet in diameter and 10 feet in height. Inside are water-drain tubes running from top to bottom and braces to hold the cushion in shape. Arthur E. McDonnell, Memphis, Tenn., is the originator.



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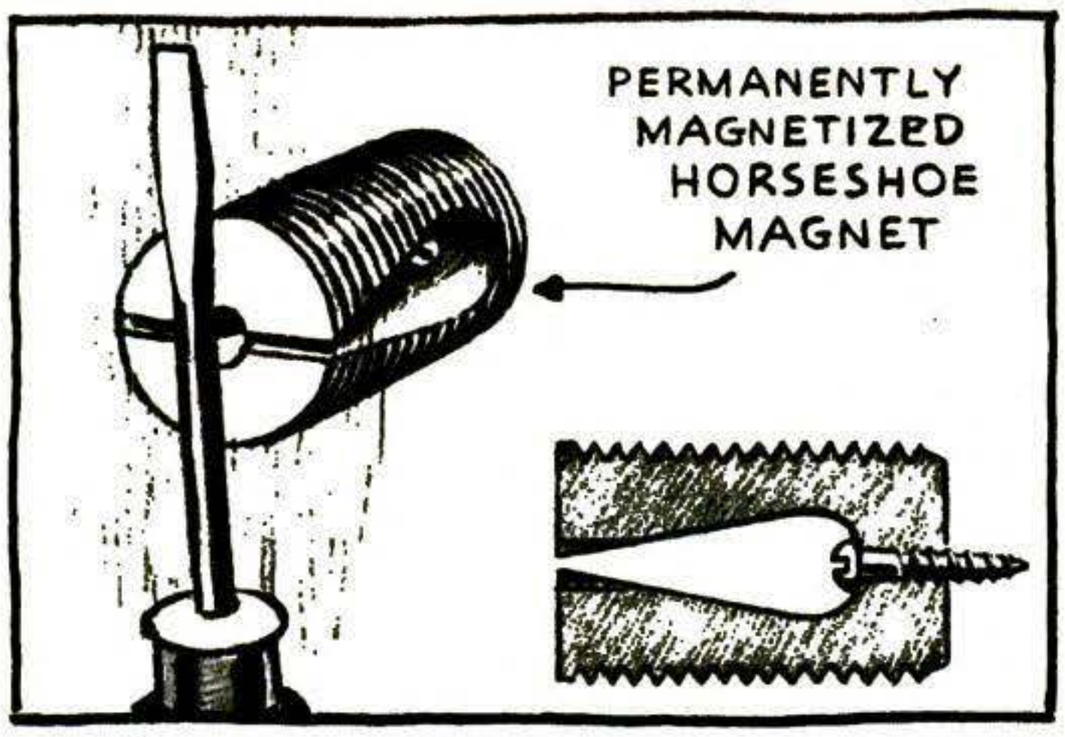
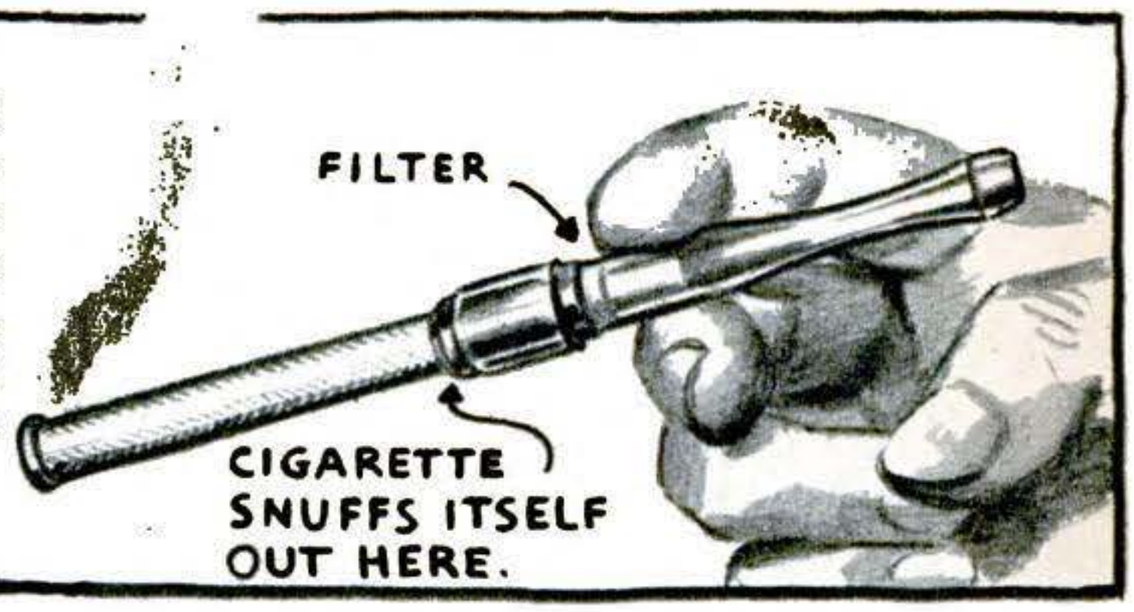
FROM THE INVENTORS

Plug with a Pull. A cylindrical magnet that screws into the wall and can be used as a doorstop or to hold tools, small machine parts, or metal price tags in place has been designed by Walter E. Burton, of Akron, Ohio. The threaded, horseshoe-type magnet would hold open an ordinary door with an iron armature attached to it, as well as a steel door. And its inventor points out that it may either be mounted flush or extending from the wall.

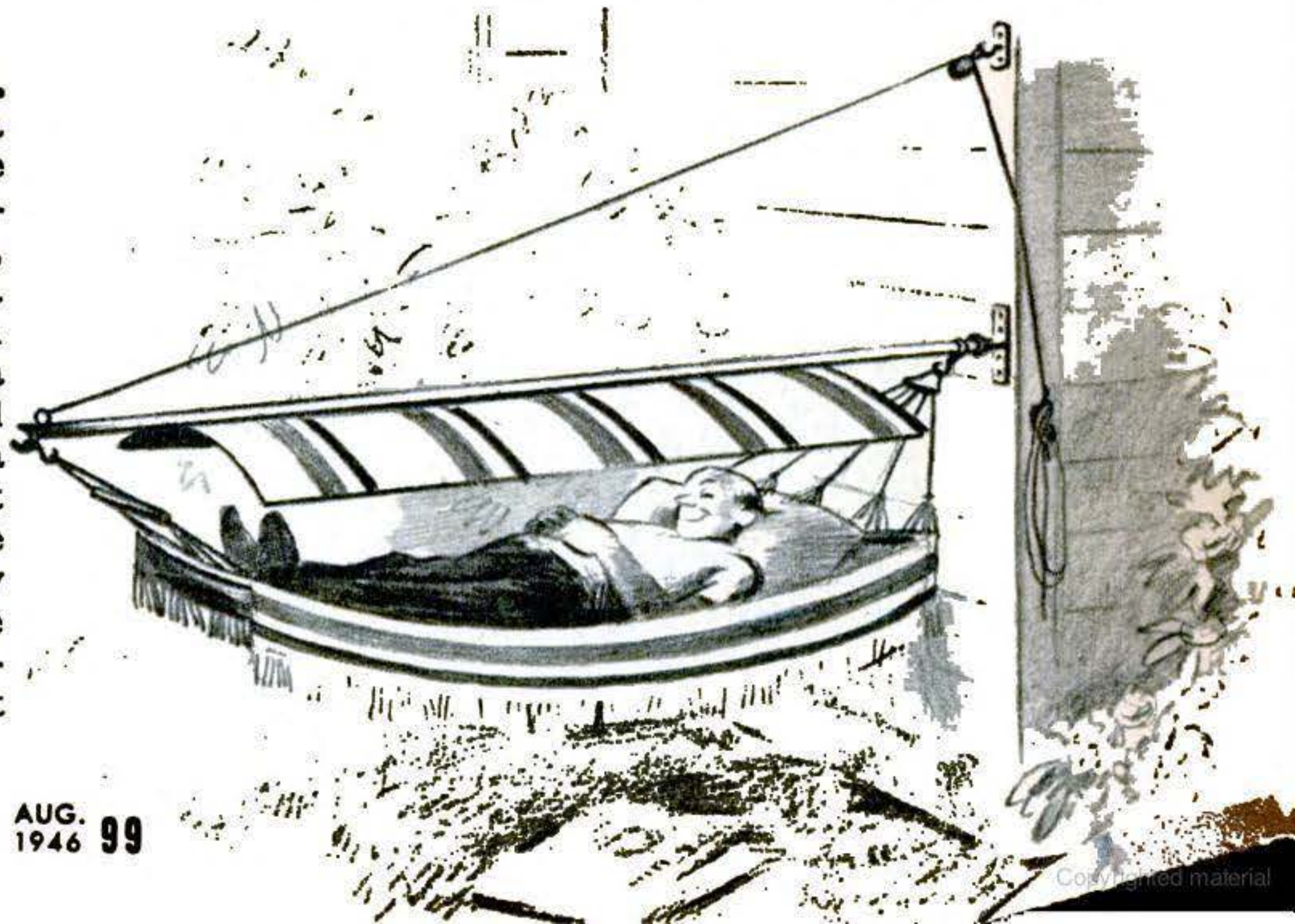


Labor-Saving Windows. Washing windows will be a cinch when housewives can have this double-hung window sash with inward-swinging panels. The invention, by Norman Goodwin, Wollaston, Mass., does not change the normal sash operation of the window, and the upper and lower panels can be opened at the same time. A weather seal between panel and sash is made of synthetic rubber tubing.

Makes Smoking Neater. This cigarette holder, invented by Don Neuberger, Cleveland, consists of a Fiberglas tube connected by a collar to a plastic mouthpiece containing a cotton filler. The pliable tube does not spill ashes, and the cigarette in it dies a natural death a quarter-inch or so from its end.



One-Anchor Hammock. Swinging a hammock becomes a problem when there is only one perpendicular support, but Edward W. Anderegg, of Algoma, Wis., has come up with a solution. His type of hammock hangs from a pole, one end of which has a base plate that can be screwed into the side of the house or a tree. The pole pivots at that point. From the other end of the pole a cable is run to a pulley fastened about two feet above the base. Thus suspended, the hammock may be adjusted to suit most reclining postures.



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1907 HUPP, "Gentleman's Sport Roadster." Leo Peters races it over Long Island roads at 30 m.p.h. The black tank on the running board is a gas generator, which brews acetylene for headlights.

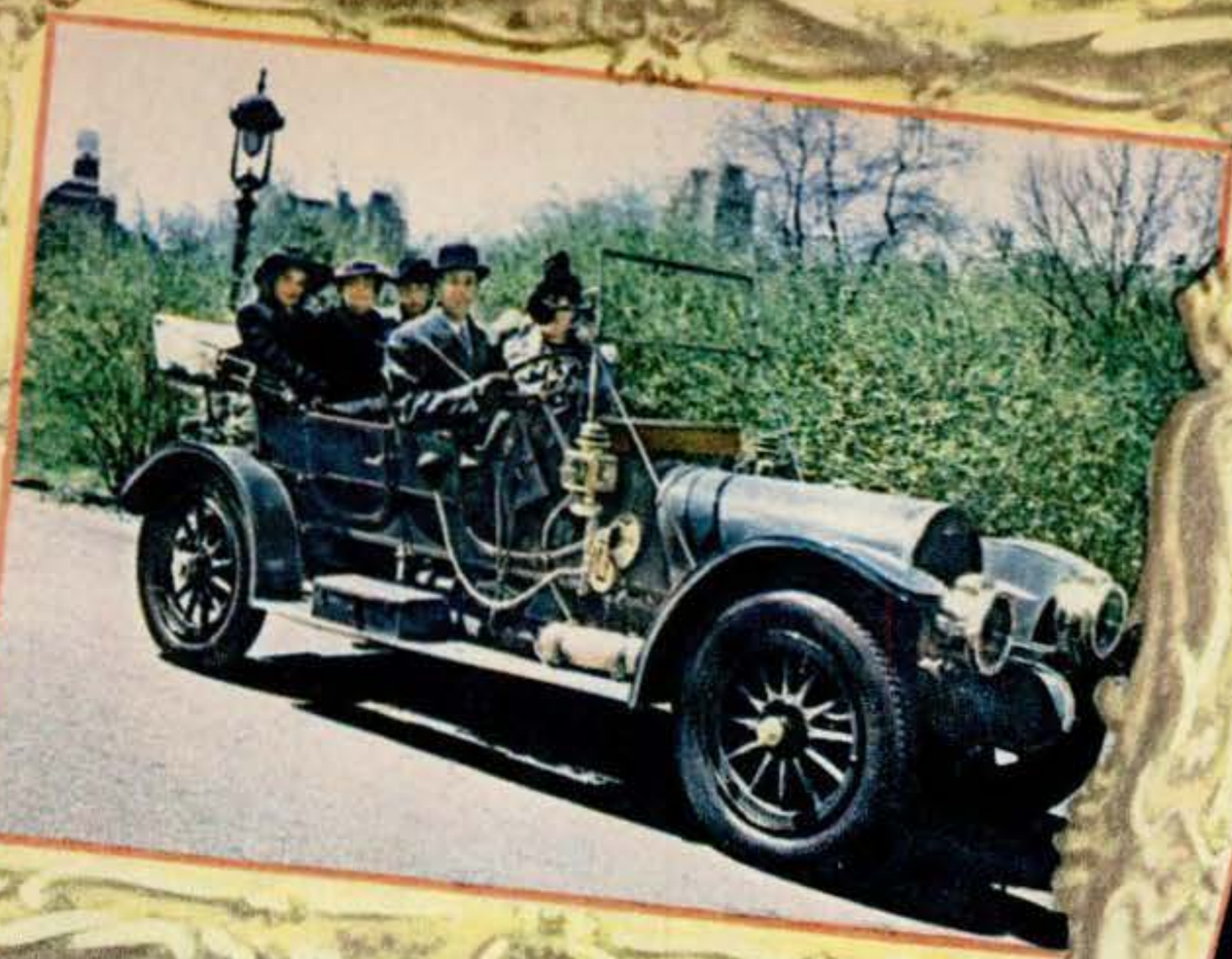
Hardy veterans

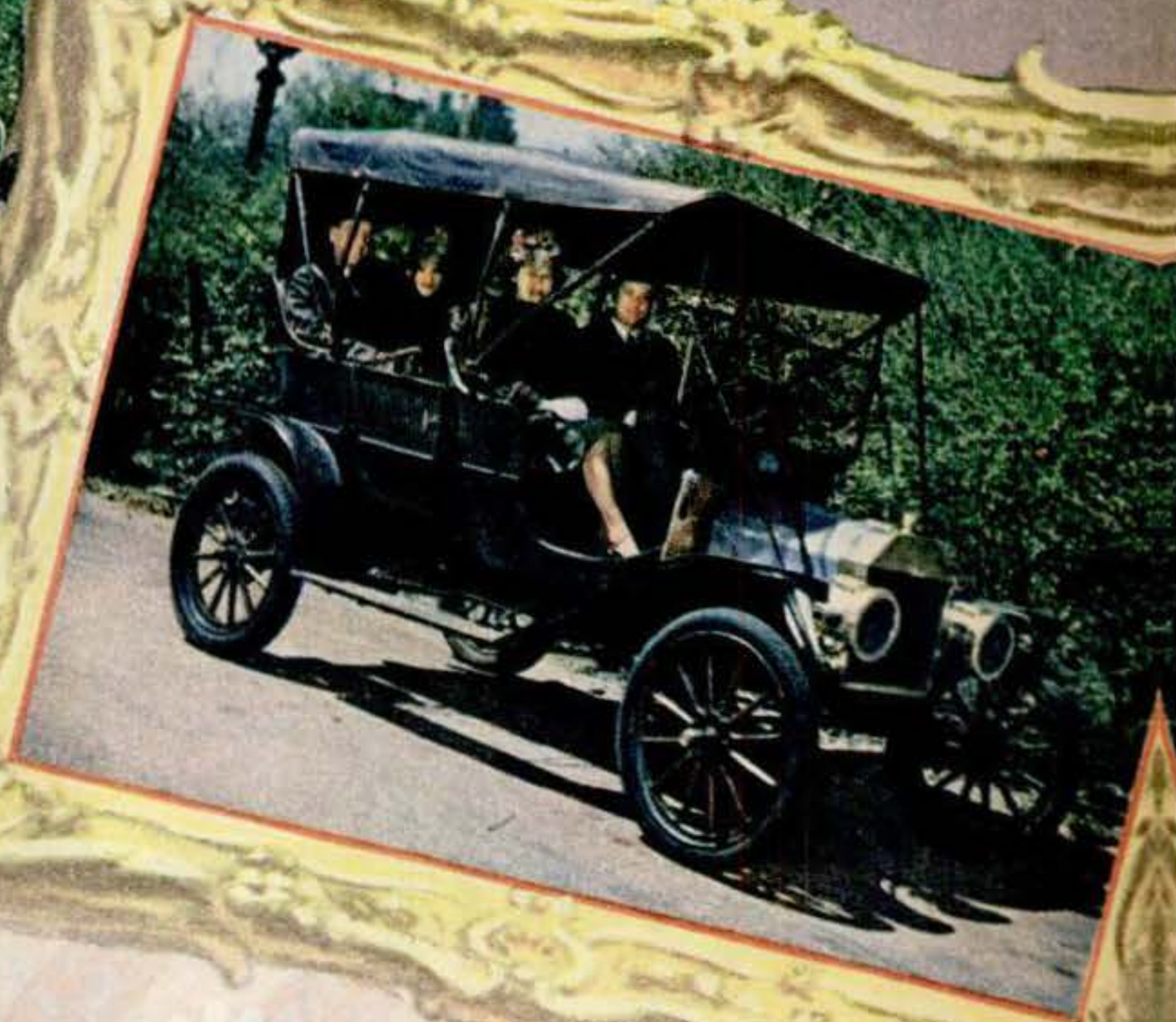
1900 OLDS runabout, owned by H. H. Park, of Katonah, N. Y., can do 18 m.p.h.—"as fast as the average man cares to travel," according to an ad. The drive chain can be tightened by lengthening the wheelbase.

1911 PEERLESS Victoria, belonging to James Melton, radio tenor, has fenders of leather, like the mudguards of old-fashioned carriages. The car has two crankcases, one for each of its two cylinders.

OLD autos that look as if they had escaped from museums are startling motorists on modern highways. They've been brought back to life by a new kind of collector—the fellow who wants to have his antique car and drive it too.

Some of these cars were found in barns, hauled out of the back corners of garages, and salvaged from junk yards. The owners got their biggest kick out of restoring the seedy vehicles. There was a thrill in coaxing a roar from an engine that was silent rust when the auto was bought.





1908 FRANKLIN. This is Model H, famous for its air-cooled engine and laminated wood frame. Each cylinder has three valves—two exhaust, one intake. Car above belongs to Leslie Gillette, N. Y.

of the highway

Other owners like the feeling of driving dangerously—achieved quite safely at 22 m.p.h. in an antique car. Drivers of old Stanley Steamers, Franklins, and other bygone makes generally have a waggish contempt for modern driving conveniences. They prefer to get out, walk around to the front, and light the headlights with a match. They prefer to crank the engine.

Frederick Elliott, secretary of the Automobile Old Timers, explains the interest as necessity: "When people couldn't get new cars they turned to the old ones."

PSM Staff Photos

1910 FORD. In 1938 two New Yorkers, F. Cecil Grace and Henry Clark, bought this touring car from a junk dealer for $20. It was one of the first 25,000 Model Ts; eventually 15,500,000 of them were made.

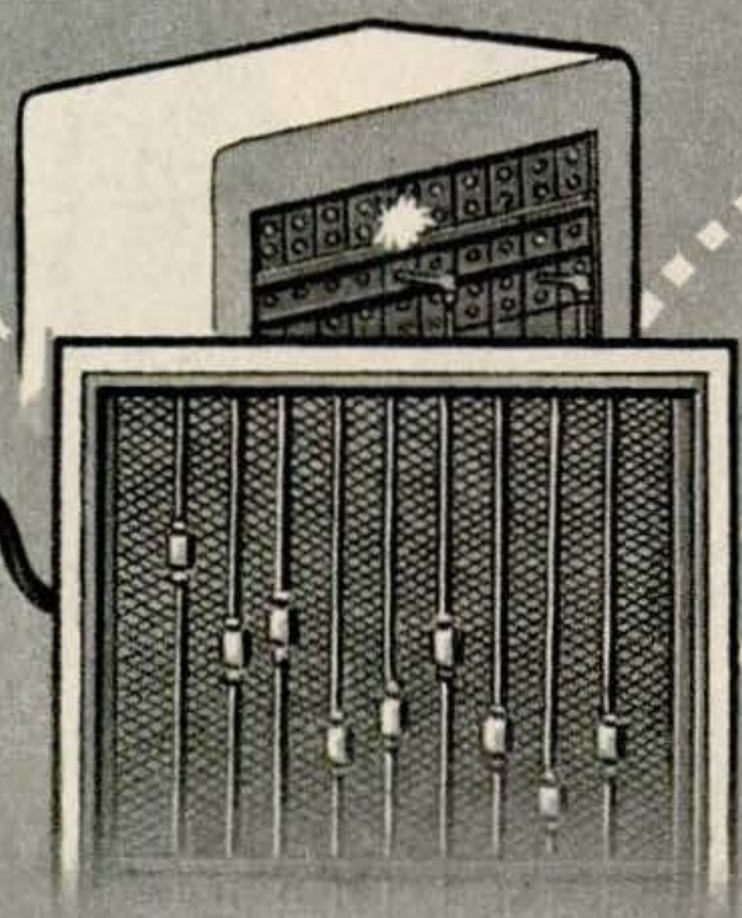
1914 MERCER Raceabout can still do 75 m.p.h., claims its owner, Sam Bailey, of Philadelphia. Its power comes from a T-head engine. It has right-hand drive, though by 1914 most car makers had dropped it.

Mechanics of LIVING

How Your Dial Phone Works

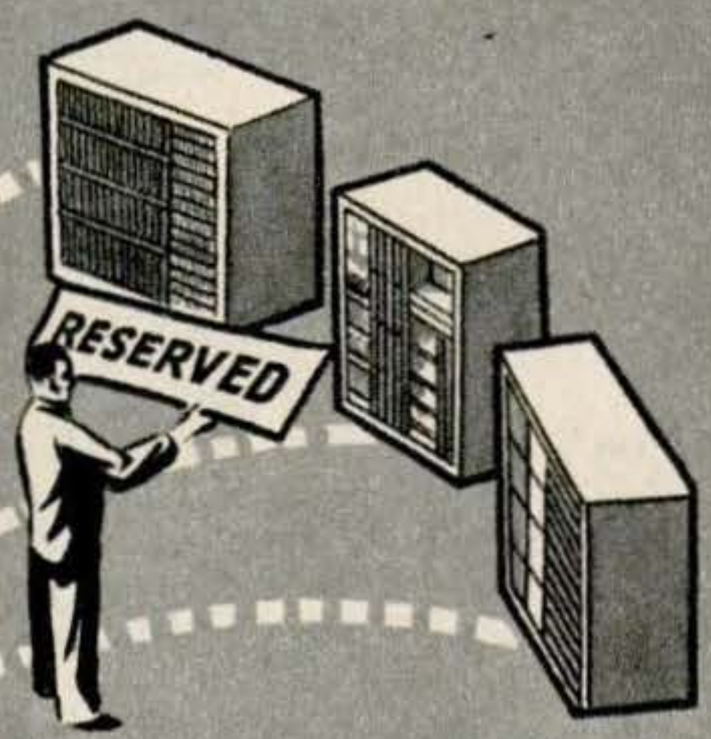
WHEN YOU PICK UP YOUR TELEPHONE . . .

The dial equipment picks out your line electrically from thousands that end in the same office. Human operator would be guided by a bulb lighting on the switchboard when your receiver was raised.



LINE-FINDER FRAME

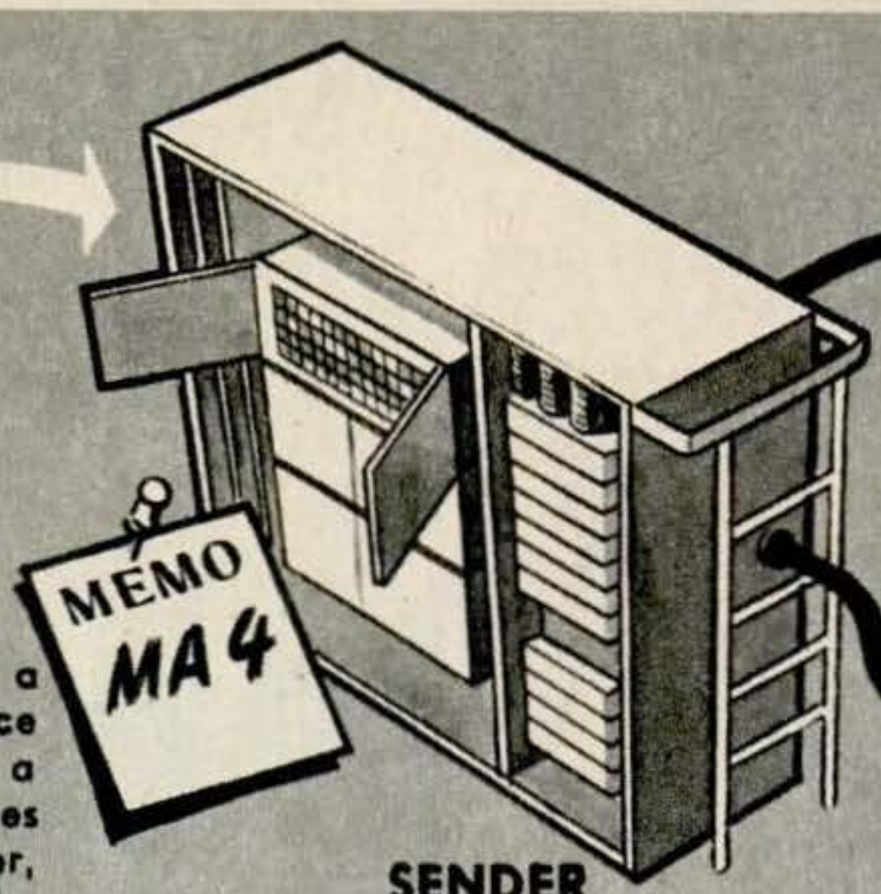
A signal goes to your line's terminus, where a metal hand with metal fingers slides along a rod, picks out your line and makes connection with it.



At the same instant, a district selector, connected through a link frame, starts a hunt for an idle sender (see below). When both the line and the idle sender have been found, you hear the hum of the dial tone, which is the mechanical operator's way of asking "Number, please?" Then you dial the number.

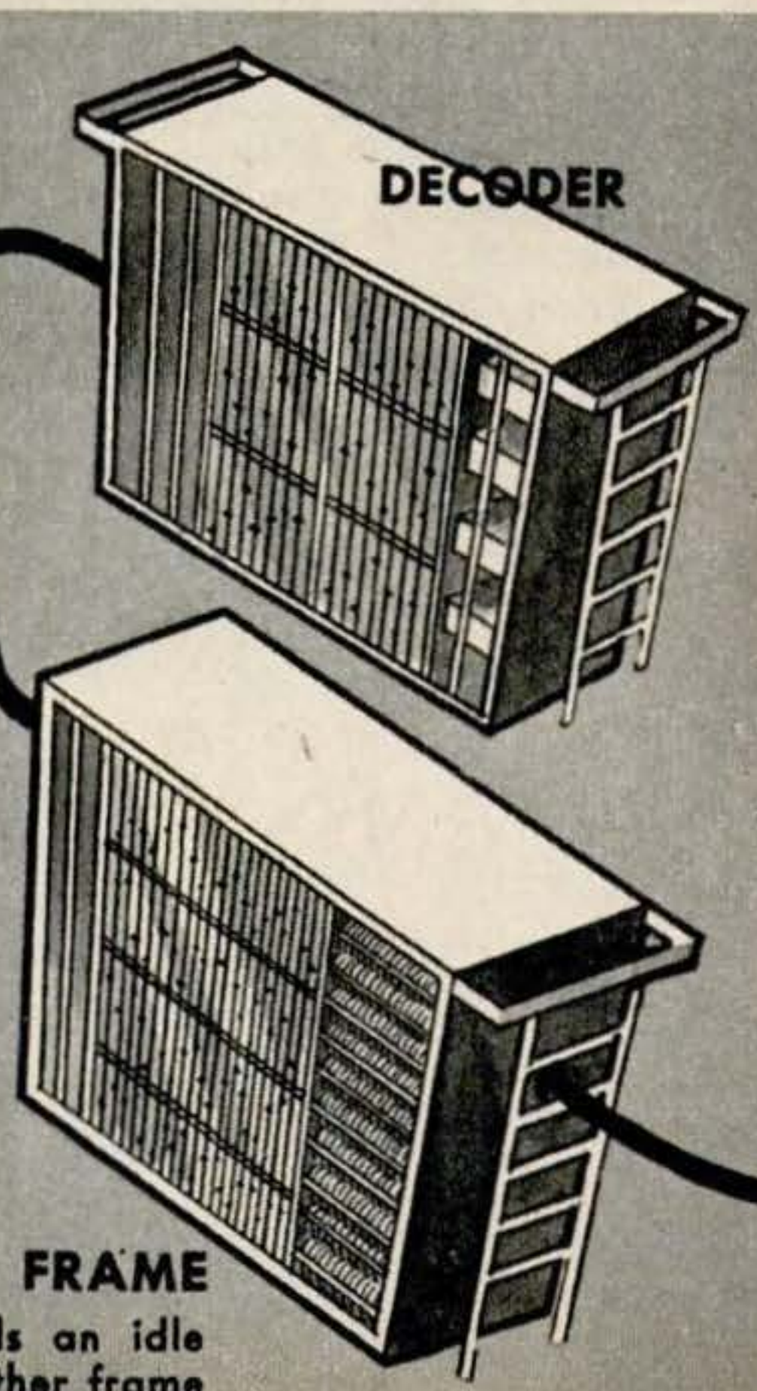
WHEN YOU START TO DIAL . . .

Each spin of the dial turns a rotary switch in the central office of your telephone exchange to a certain position. These switches record the number in the sender, which is ready now to get the number for you. After the first turns of the dial, which designate the central office you are calling, the sender instantly consults a decoder to determine how the call should be routed.



SENDER

The sender is the "brains" of the system. It remembers the number you dial and knows how to direct the making of a connection with the line you are calling.

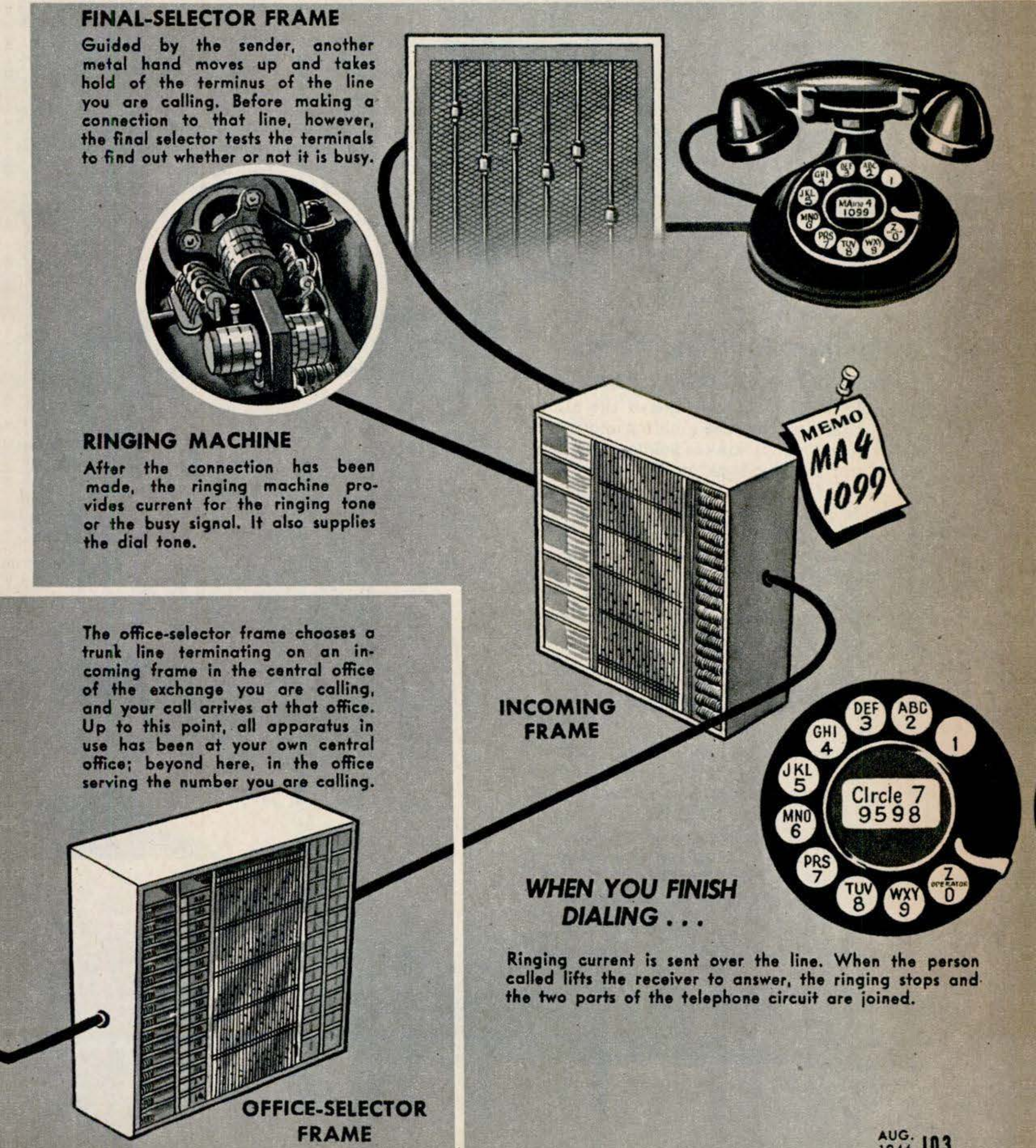


DISTRICT-SELECTOR FRAME

The district selector finds an idle trunk line leading to another frame —the office-selector frame.

NEARLY two-thirds of the 28,000,000 telephones in the U. S. today are dial phones. Thirty-five years ago there were none. A few years from now nearly all phones will be dial phones; how many, telephone company officials hesitate to estimate. There are many thousands of orders on file in New York City alone. Further, long distance calls are now being dialed, with the aid of an operator, in Richmond and Philadelphia. Eventually they will be dialed straight through from coast to coast.

This is how your dial phone works. It has 429 parts. The system gets your number, however, by going through the same steps as a human operator. It simply uses electrical switches instead of fingers. Tall panels, or frames, in the dial central office replace the switchboards. You get the same old "hello"—but faster and surer.



WHEN YOU FINISH DIALING . . .

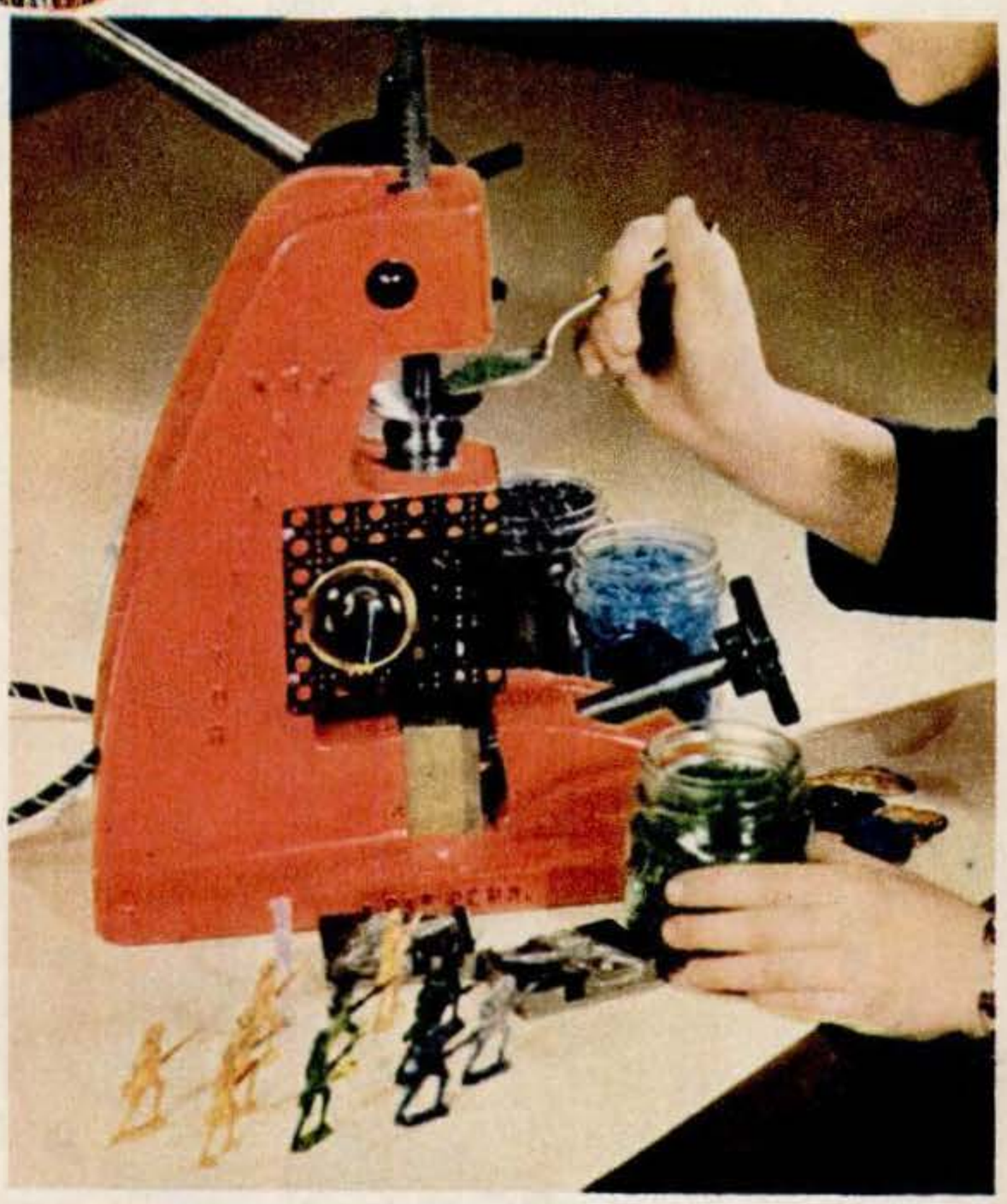
Ringing current is sent over the line. When the person called lifts the receiver to answer, the ringing stops and the two parts of the telephone circuit are joined.

President's Flag Has Been Corrected

THE eagle on the President's flag used to face the wrong way—to its left. Before his death, President Roosevelt ordered a new flag to correct this error. Designed by Com. Byron McCandless and approved by President Truman, the new flag (left) is now ready. Within a ring of 48 stars, the eagle proudly faces right. (U.S.NavyColorphoto;Acme)

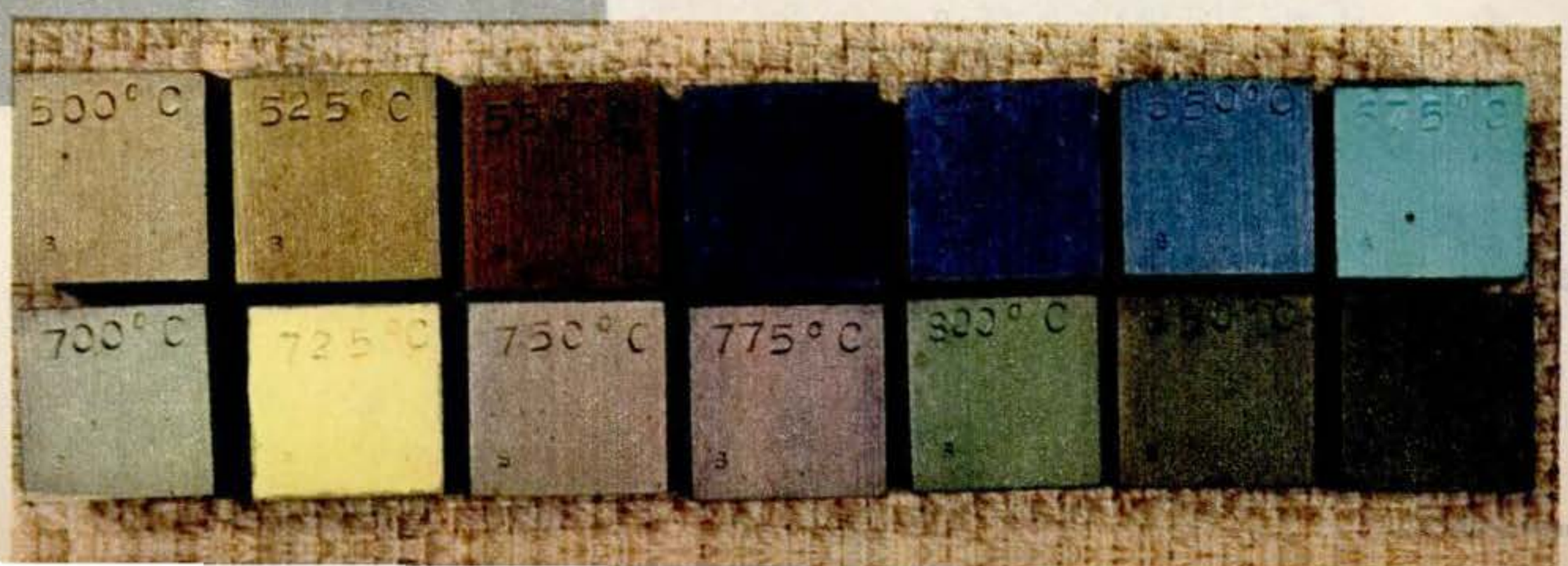
Miniature Machine Molds Plastic Toys, Decorations

CONSTRUCTED on the lines of the giant machines used by the molding industry, the Plasticor (right) makes soldiers, horses, Indians and similar toys or decorative objects. It is 12 inches high, weighs about 17 pounds, and has a heavy aluminum frame. Colored Tenite pellets are fed into the electrically heated loading chamber, where they are melted, and forced into a mold by a hand-operated plunger. The plastic hardens immediately into a finished toy.



Metal Reveals Turbine Heat

TO RECORD more reliably the intense heat created inside a gas turbine, General Electric engineers made turbine parts of chrome cobalt, a special alloy that tells temperature by color. A strange characteristic of the alloy (see blocks below) is that after it completes one scale of colors, it begins again and repeats the colors through a higher range of temperature.



Making 1,125,000 matches an hour

PSM Photos by W. W. MORRIS

It requires 32 chemicals and odd machines two stories high.

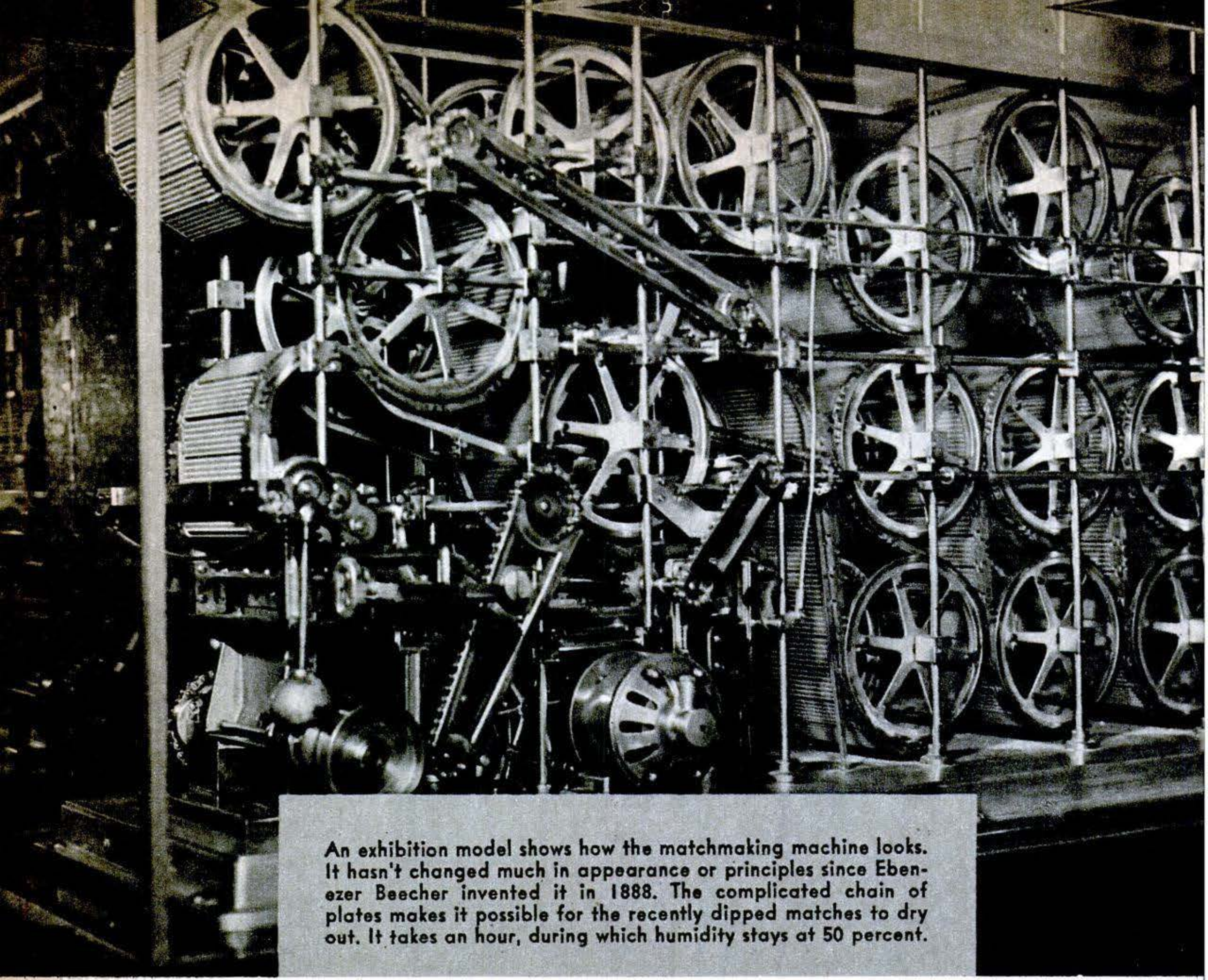
By WILLIAM P. VOGEL, JR.

IN THE second it takes you to read this line, 16,000 matches are being struck in the United States. This is consumption at the rate of 500 billion a year. Every year Americans fire up about 200 billion book matches, 100 billion wooden safety matches and 200 billion kitchen matches—the familiar "strike-anywhere" matches with the brightly colored heads.

Matches became scarce during the war, when the military services needed them by the shipload. The shortage arose because match manufacture is expensive and difficult, requires large, heavy machines, quantities of cheap lumber, big freight-car movements. The match industry couldn't expand its plant, so it stepped up production as best as it could by running machines faster and by improving the product to cut down rejects.

Battalions of matches, heads up, parade above in various stages of manufacture: as splints; after bulb dipping; and with their tips on.

In huge vats the match-bulb composition, kept warm by steam, is stirred by rotating rods. Material for making tips is mixed in much the same way.



An exhibition model shows how the matchmaking machine looks. It hasn't changed much in appearance or principles since Ebenezer Beecher invented it in 1888. The complicated chain of plates makes it possible for the recently dipped matches to dry out. It takes an hour, during which humidity stays at 50 percent.

Huge machines 60 feet long and two stories high produce about 1,125,000 kitchen matches an hour. Raw billets of white pine are fed into one of these machines and 60 minutes later are converted into finished matches, generally packed 360 to a box that sells for a nickel. These strike-anywhere matches must produce a fire train as precisely controlled as the fire train in a high-explosive shell. The match must flare readily—but not too readily—under moderate friction. It must burn smoothly, evenly and quietly, without scattering sparks. It must not drop incandescent ash on the floor, and it must not smoke and smell like a smudge pot. It must withstand extreme variations in climate, and it must not glow after it has been put out. Above all, it must be nonpoisonous.

Although matches of a sort have been known since 1680, the modern strike-anywhere got its start around 1910. That year an ingenious engineer named William A. Fairburn, now president of the Diamond Match Company, saw the possibility of using an old French formula for a nonpoisonous match. Within two years he had adapted the process to U. S. mass-production methods and had found a way to impregnate the wood splint to prevent afterglow.

Instead of using the highly toxic elemental phosphorus in the tip of the match, Fairburn used safe, nonpoisonous phosphorus sesquisulphide. No longer did match workers live in constant dread of necrosis (they called it "phossy-jaw"), which destroyed their bone tissue, caused their teeth to fall out and their jaws to drop off, and finally killed them. No longer did mice, nibbling at the tasty (to mice) phosphorus tips, cause drastic fires. "Sesqui," as the match men call it, made the modern match possible.

A sesqui-tipped match produces a bright, intense fire. The heat resulting from this instantaneous reaction must be put to useful work. This is where the bulb comes in—the part of the head that lies below the tip and hugs the wood. The principal chemical in the bulb is potassium chlorate. The heat of the tip causes it to burn, and in

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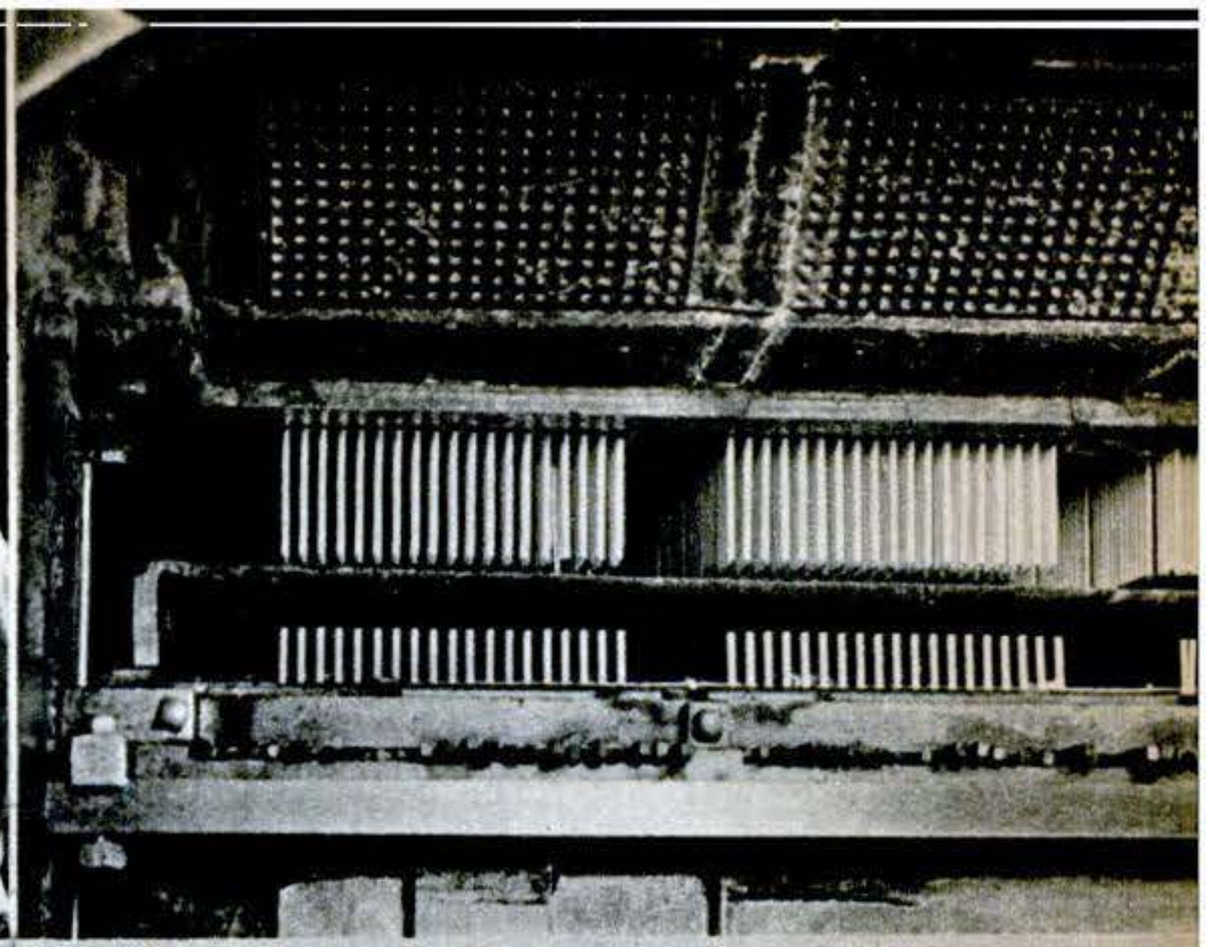
Blocks of white pine are fed into the cutting head of the machine. Billets are two inches wide, 2⅛ inches high, with vertical grain. Prewar matches measured 2⅜ inches, but WPB ordered ¼ inch lopped off.



Cutting head has just completed slicing blocks into splints—420 per minute. The head is now beginning its upstroke, which will be completed when the splints are rammed into holes in the plate above.

doing so it liberates all its oxygen. The oxygen is necessary to start the combustion of all the other elements in the match head, including the wood of the splint. To make doubly sure that the fire train will get a good start on the wood, the top half-inch of the match is dipped during manufacture in paraffin, making it a kind of candle.

The match is now alight. A shake of the hand or a puff of breath puts it out. The wood must not continue to glow. Again chemistry comes to the rescue. During manufacture, the wood has been impregnated with a solution of ammonium phosphate, a leader in the great family of fire retardants. This quenches any flame that might linger in the wood fibers.

All told, around 32 different chemicals are used in matchmaking. Some are aniline dyes that give the matches their gay colors to help them sell in a competitive market. Others, like animal glues, starches and dextrins, gums and resins, hold the different components together. Formaldehyde preserves the match during long periods of storage. Inert materials such as pulverized earth, quartz, glass, clay, and plaster of Paris slow down the fire train and give the active chemicals the required degree of hardness.

The chemicals are bound to the wood in the match machine, an invention of Ebenezer Beecher in 1888. Improved and speeded up since then, the machine shows no influence of modern industrial design. It is awkward, ungainly and noisy, and looks a good deal like an engineer's nightmare.

To meet the present demand for matches, the cutting heads on most machines that gouge the match splints out of the pine blocks have been speeded up from 350 to 420 strokes per minute. The resultant roar, clatter and vibration are terrific.

After the splints have been cut by the downward stroke of the cutting head, they are rammed by the upward stroke into little holes in an endless chain of linked steel plates. Most big machines have 2,000 plates capable of receiving 42 or 57 match splints at a time. The splints, advancing like an orderly army, are first sprayed with ammonium phosphate squirted out of a jet that swings rapidly like an inverted windshield wiper. After a short drying time in hot air, the splints are dipped in paraffin and then into the bulb composition. The next step is the application of the tip, after which the matches get their preservative spray. Then the plates move slowly along the upper reaches of the machine to the punch-out end.

Here is the greatest activity in matchmaking. An operator, closely watching the plates as they descend toward her, plucks out matches with broken splints, smashed or oversized heads. As the plate approaches a covered, vibrating conveyor, little rods strike the plate from behind and punch the matches out of the holes. Tumbling onto the quaking conveyor, the matches are jogged so that all their heads soon point in the same direction. After more rejects have been pulled out by hand, the matches are dumped, 180 at a time, into boxes that are shaken to settle the contents. The half-full boxes then make a semicircle under the conveyor and get the second half of their load with the heads pointing in the opposite direction so the box will pack flat. As the boxes advance toward the final stages in manufacture, their covers are squeezed on and they are packed into cartons ready for shipment.

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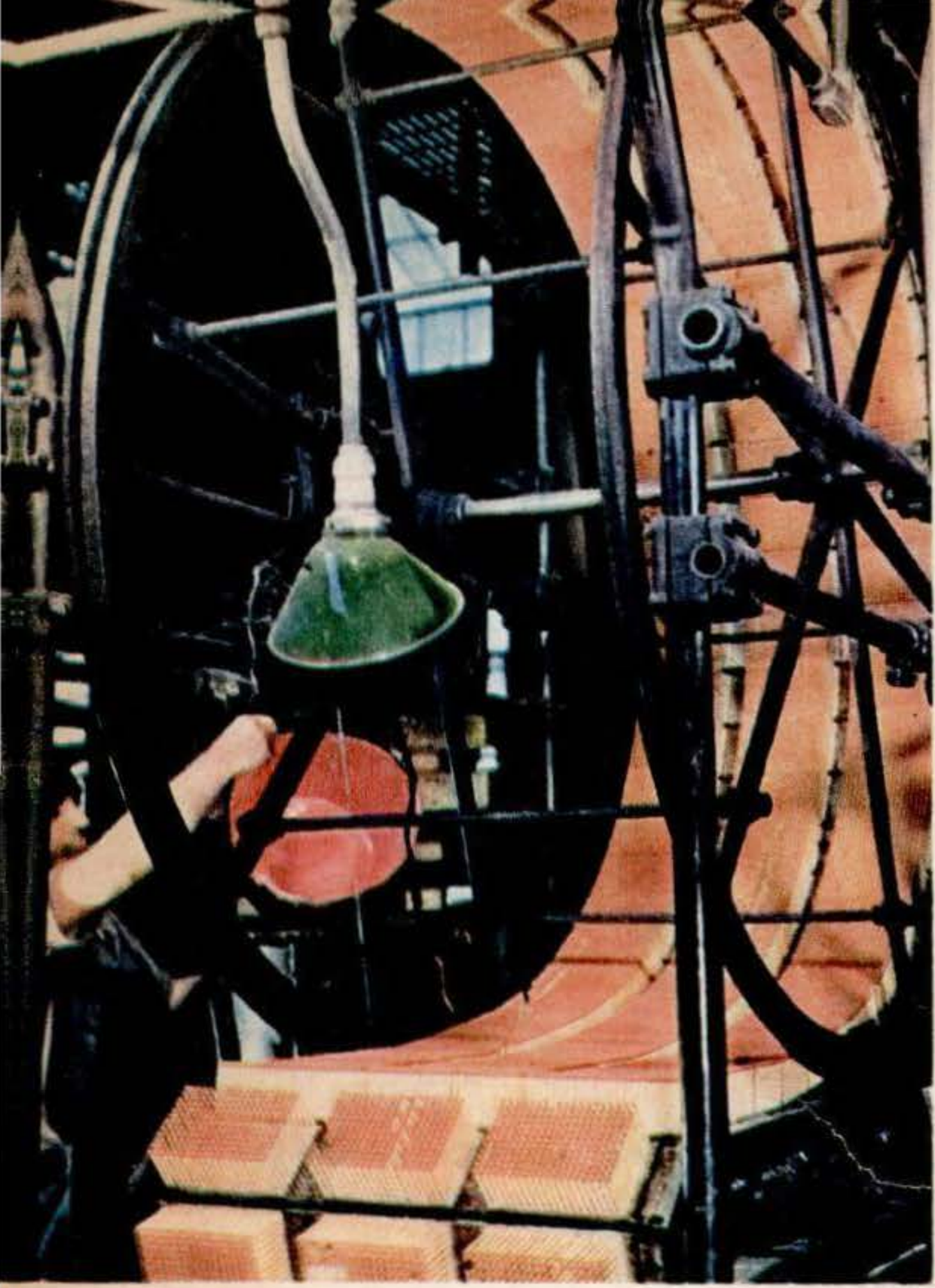
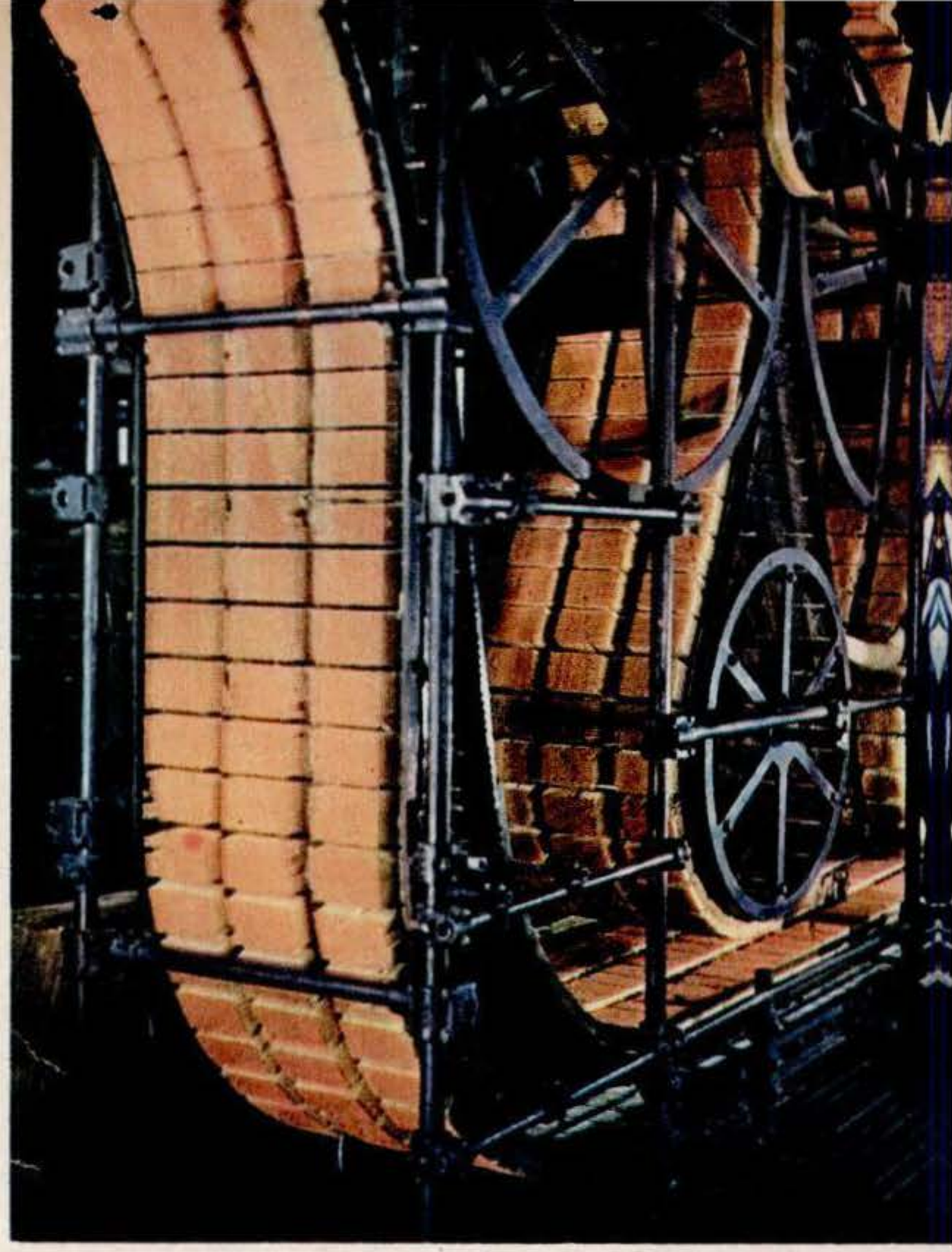
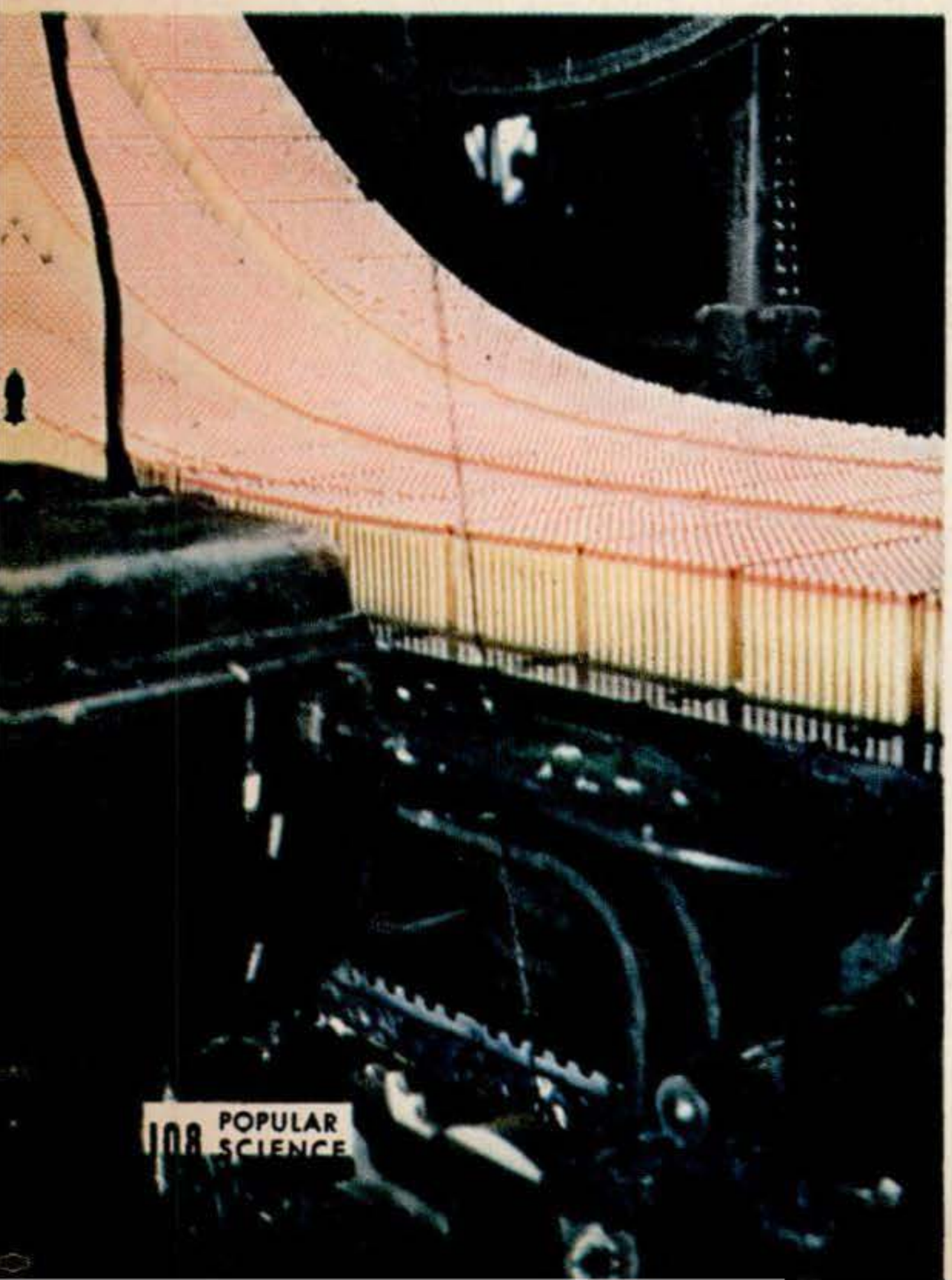


1. Once splints are inserted in plates, they are sprayed with ammonium phosphate solution to retard afterglow, and begin an hour's journey.



2. After the top half is dipped in paraffin, plates swing upward, traveling around huge wheels for an accurately gauged drying period.

3. Ten minutes after the bulb dip, matches are dry enough to be tipped. Tips are applied as the bulb mixture was, and dried as matches swing upward.



4. At the punch-out end they leave the plates and flow on a moving belt to packaging and inspection. Operator plucks out defective matches.

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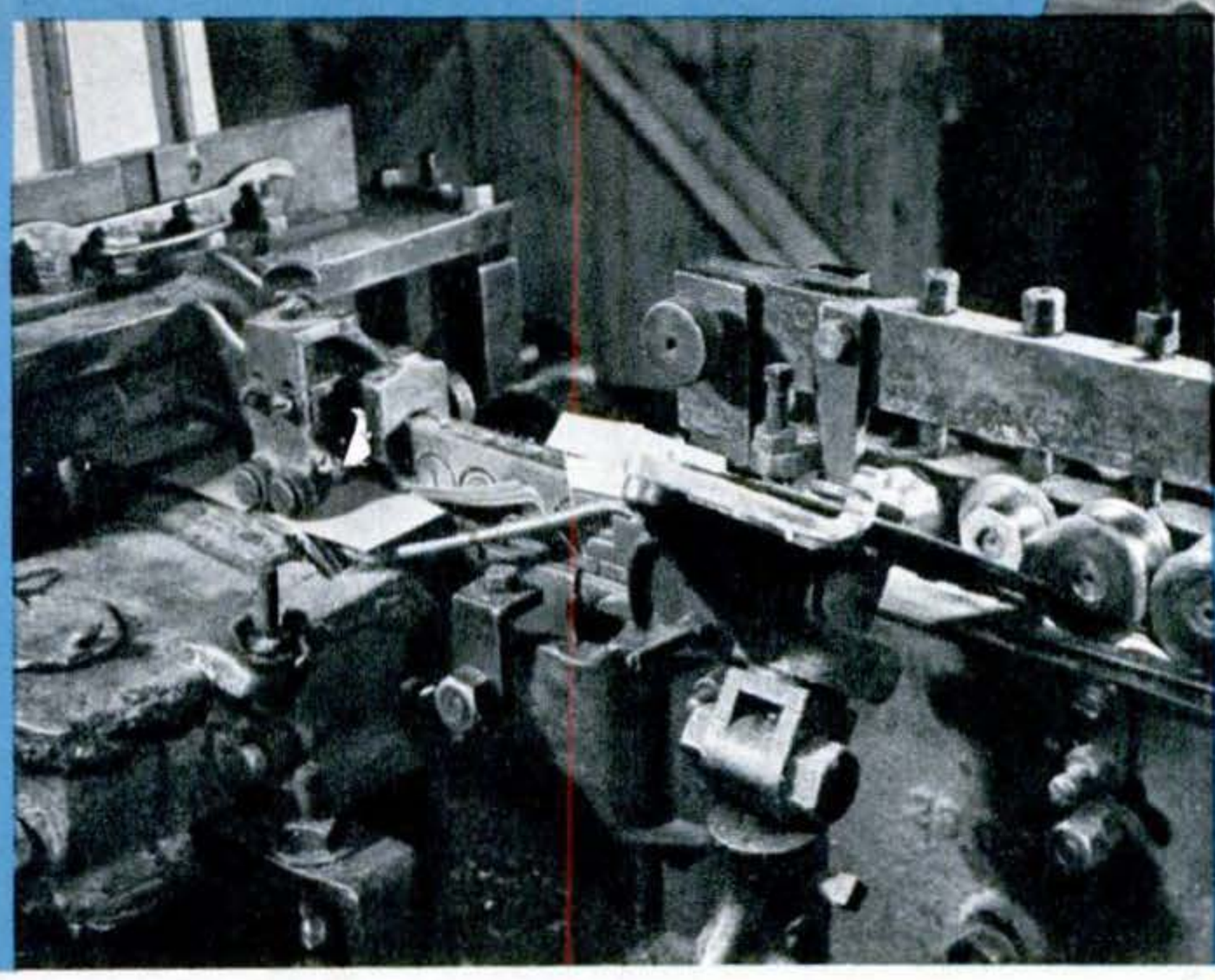
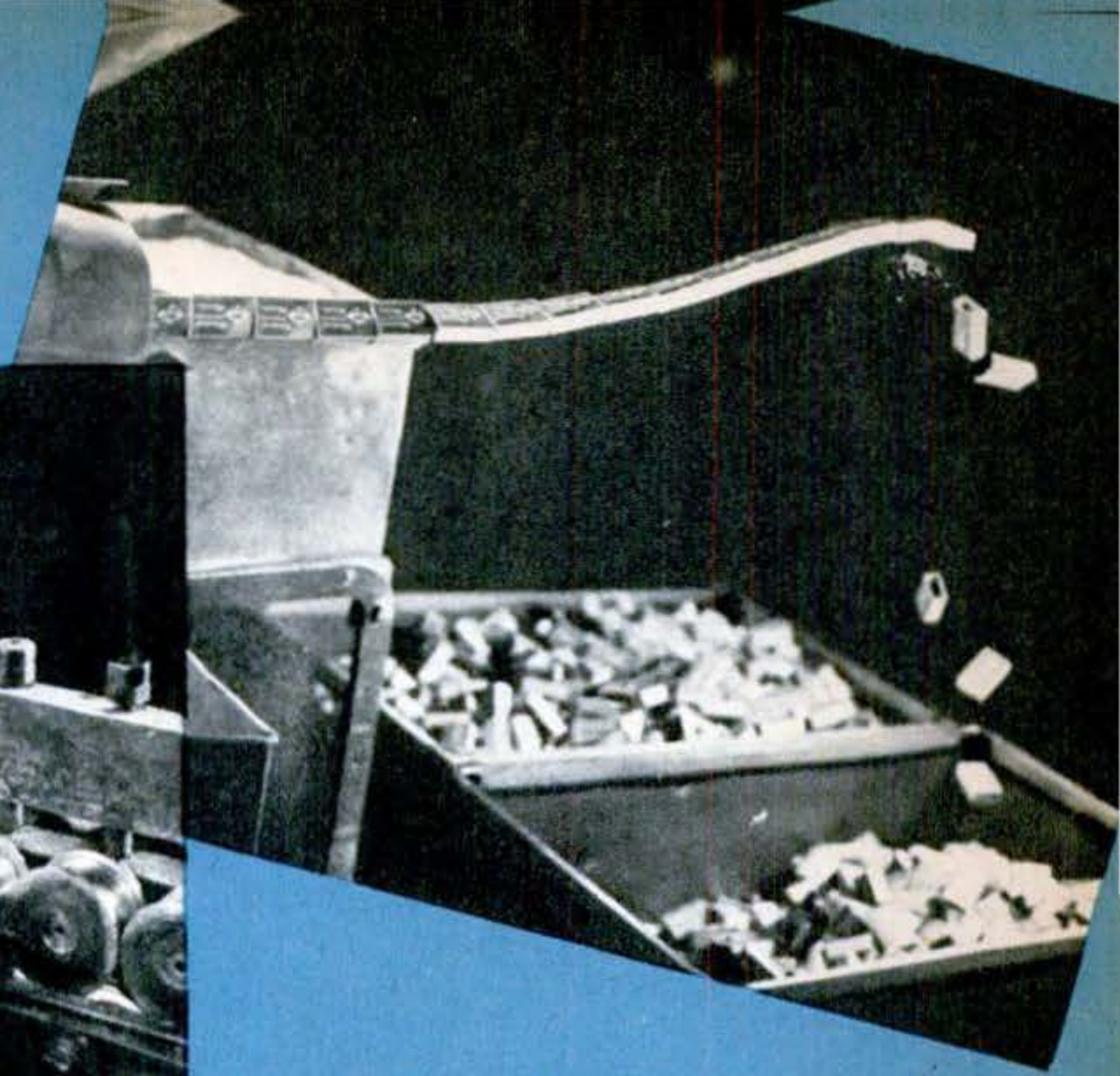
The machine below folds and glues printed cardboard, converting it into small matchboxes. It includes a sanding hopper where a scratching surface is applied just before . . .





. . . the completed box covers, sanded on both edges, issue in a stream at the rate of 700 an hour. They are now ready to be packed.

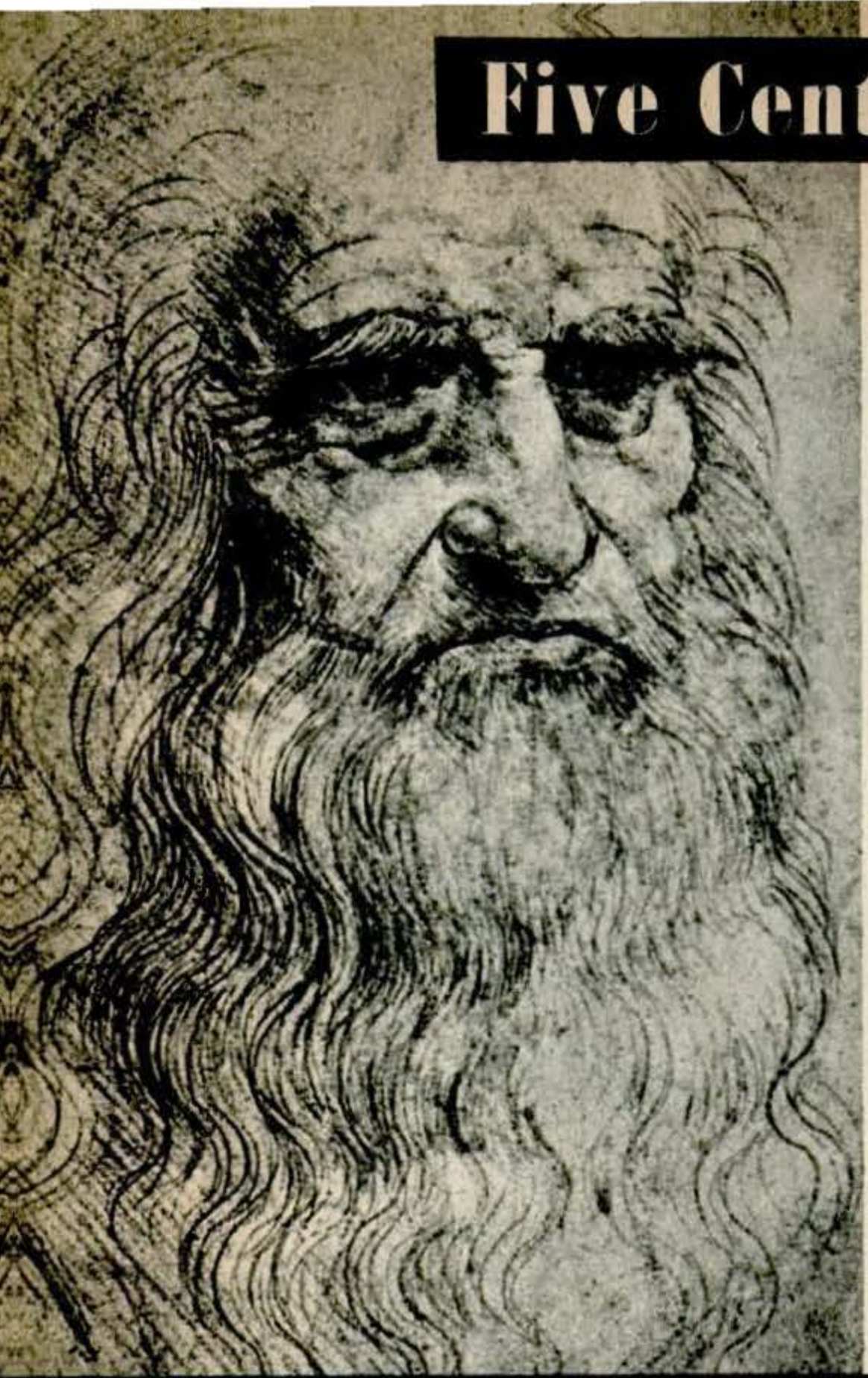
To solve the basic problem of getting huge volume and at the same time giving the matches time to dry out, the match industry had to go deeply into air-conditioning. All matchmaking takes place in rooms where the temperature and humidity are carefully controlled. In making wooden matches it was found that the bulbs were ready for packing at the end of the 60-minute cycle if the relative humidity was maintained at 50 percent and the temperature of the wet bulb was 60 degrees F. As the matches dry out during their tour through the machine, enough fresh air must be blown into the room to absorb from 20 to 25 pounds of water per million matches. If the air is too wet, the heads will smash in packing and the matches will stick to the box. If it is too dry, the matches will dry on the surface only, and, with moisture inside the bulb, they will be dangerous to use.

If a match is pampered a bit it will continue to burn about 29 seconds, yet making that match took 50 years of intensive industrial development and an hour of complex mechanical processing.

Matches to be packed in penny lots are deposited in small boxes, which move on a conveyor to meet covers. Cam-actuated dogs push boxes into covers.

Testing matches for afterglow and comeback. Those burning must go out after flame dies down—otherwise 200 boxes before and after are destroyed.

Five Centuries Ahead of his Time

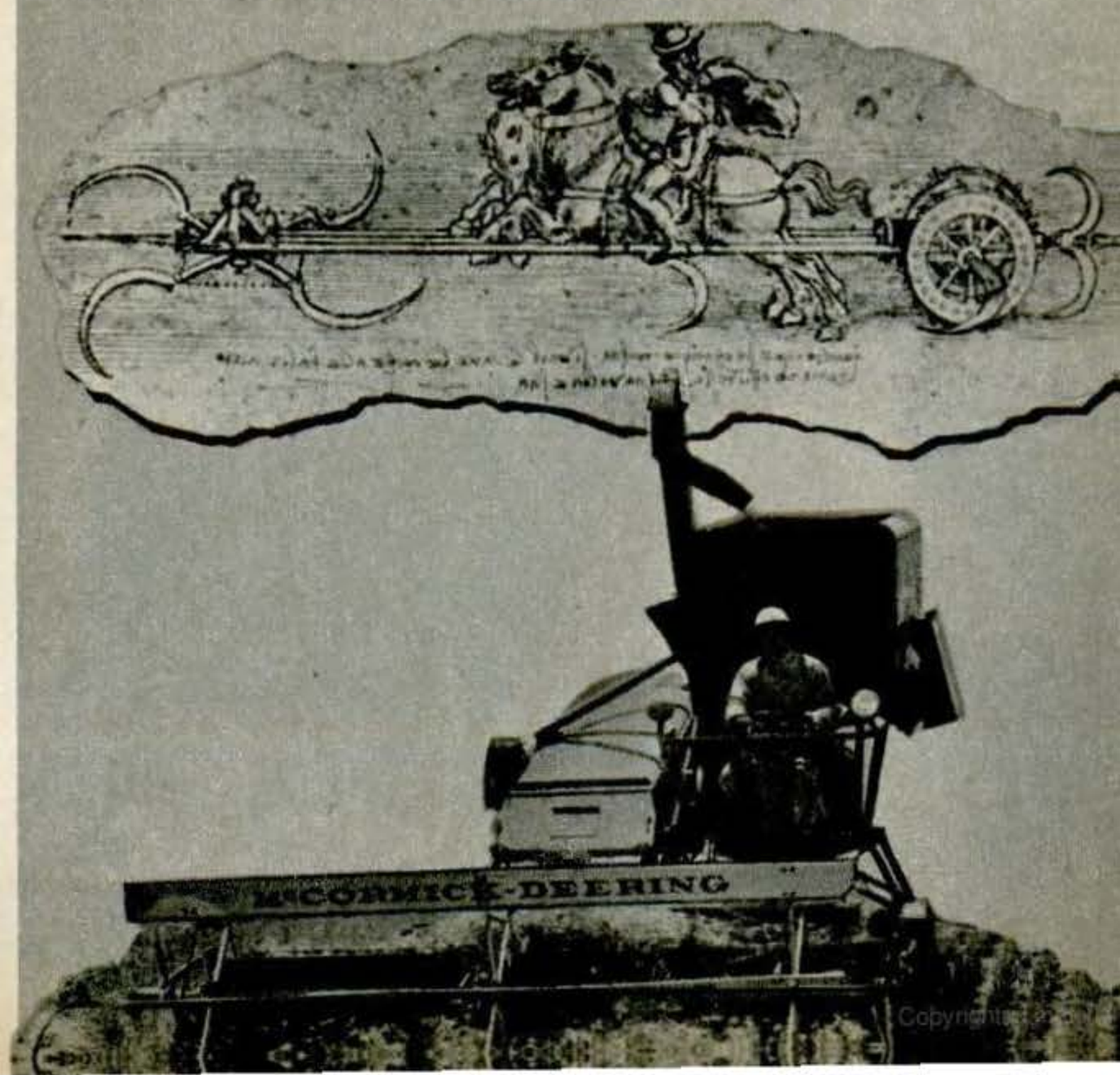


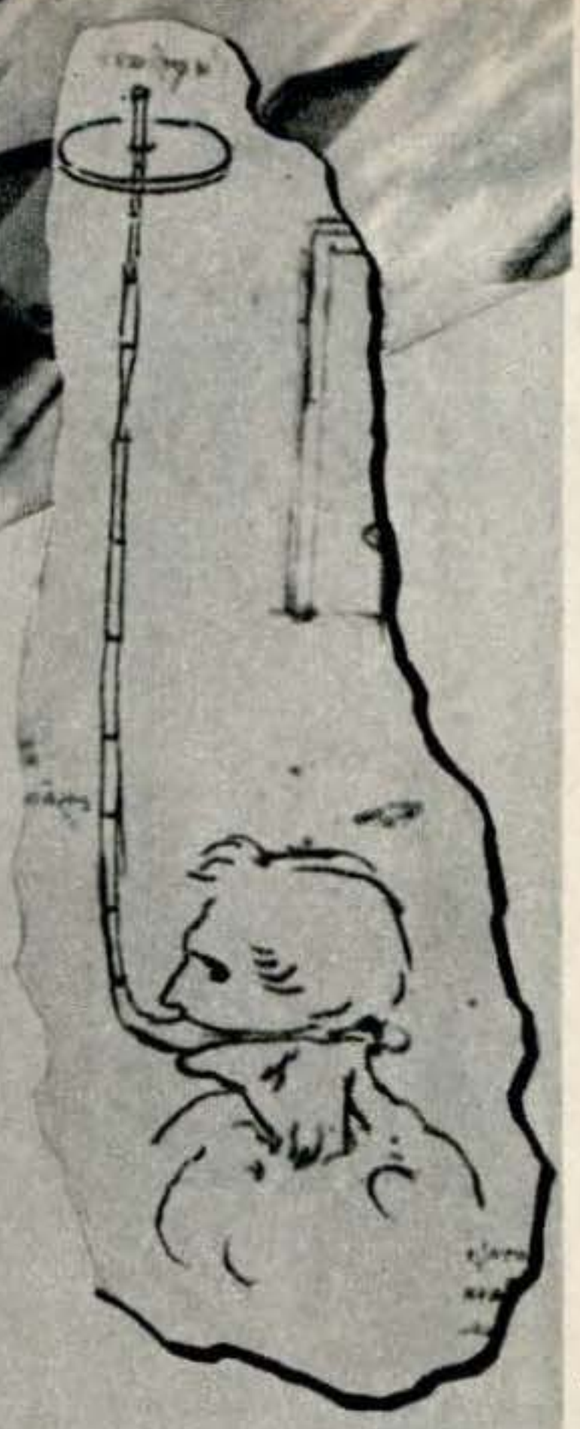
Leonardo da Vinci sketched machines and devices that only recently have taken form.

LEONARDO DA VINCI, one of the world's great artists, possessed an invincible curiosity, a logical mind, and a creative imagination. As a result, this son of a Florentine lawyer pushed back the frontiers of almost every branch of science. Born 40 years before the discovery of America, Leonardo made many discoveries and inventions centuries ahead of his time. A reader of his "Notebooks" will find more than 25 proposals that have taken concrete form—many of them only recently. Here are some of his mechanical sketches—together with the modern devices that made them realities.

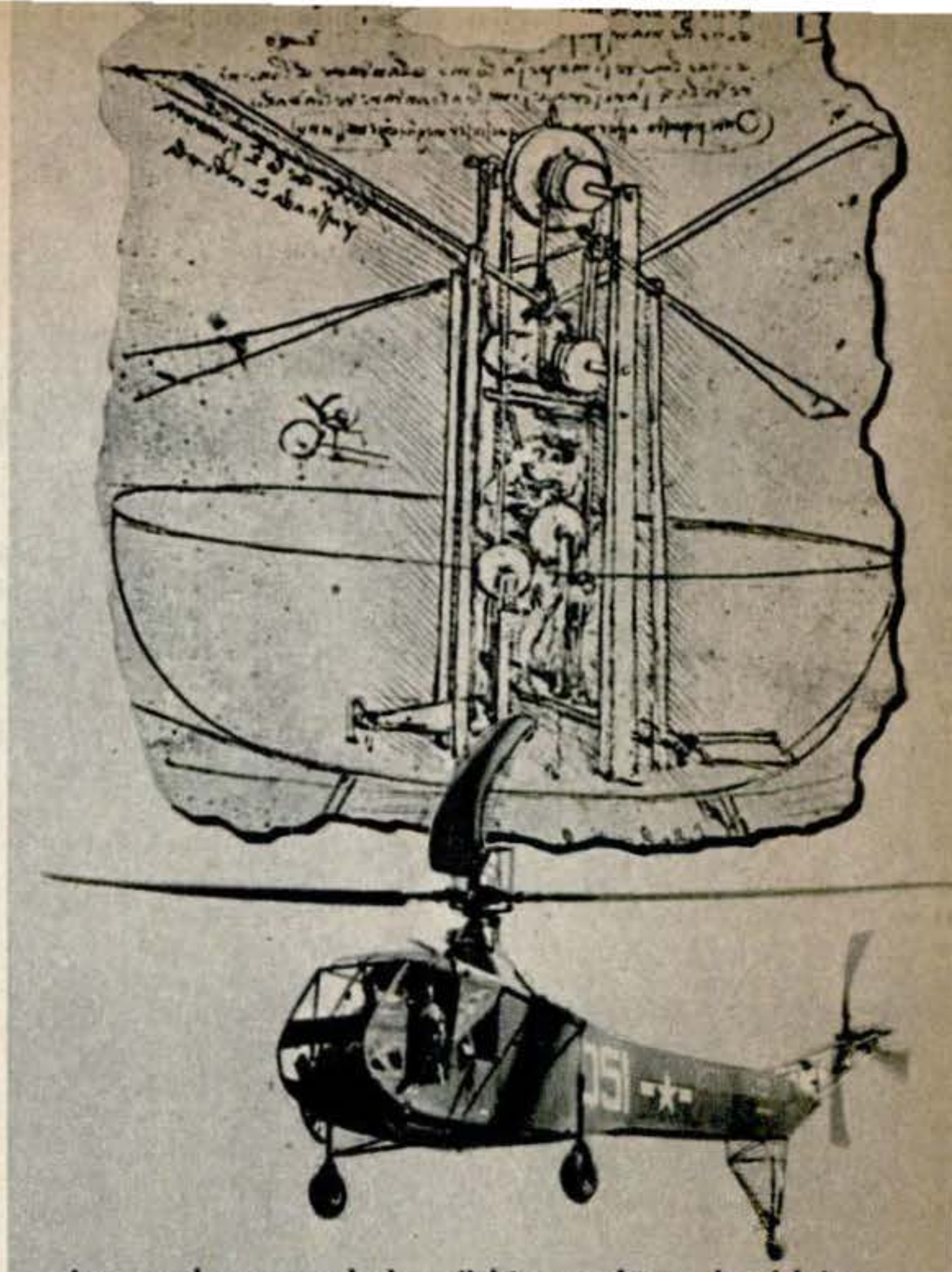
The notes with this drawing read: "How the armored car is arranged inside. It will need eight men to work it and make it turn and pursue the enemy. This is good to break through the ranks but it must be followed up." He gave no inkling of the motive power, but his description might just as aptly apply to some of the huge tanks of World War II as to the devices he was then elaborating.

Leonardo noted that "when this is going through its own ranks, it is necessary to raise the machinery that moves the scythes, in order to prevent their doing any harm to anyone." This device was ineffectual as a military weapon, but it holds the germ of the modern mowing machine. In his famous letter to Ludovico Sforza, Duke of Milan, he wrote of the many "engines of wonderful efficacy" he could supply.



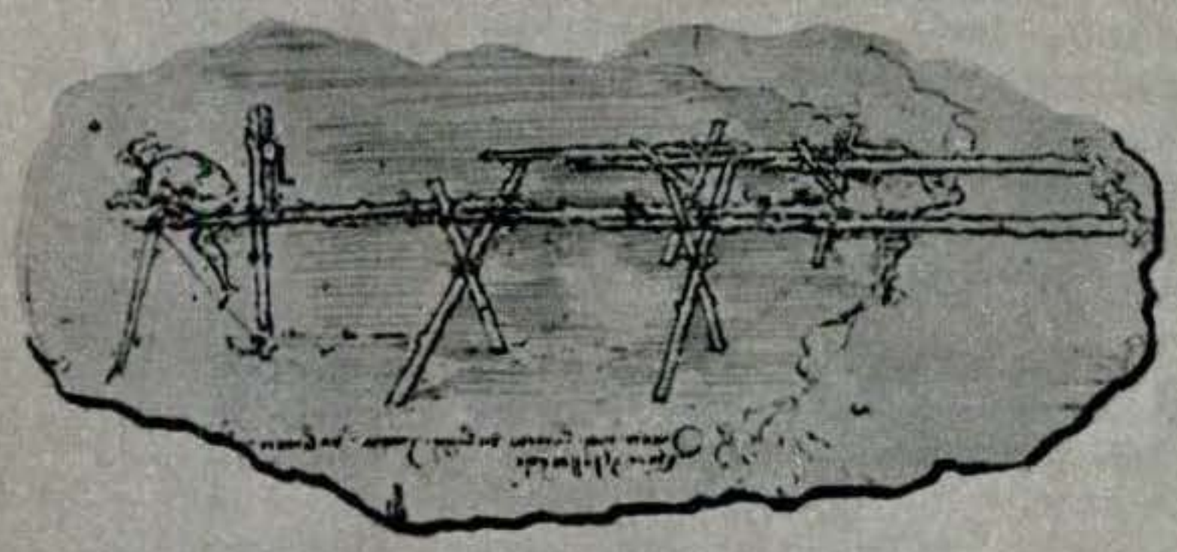


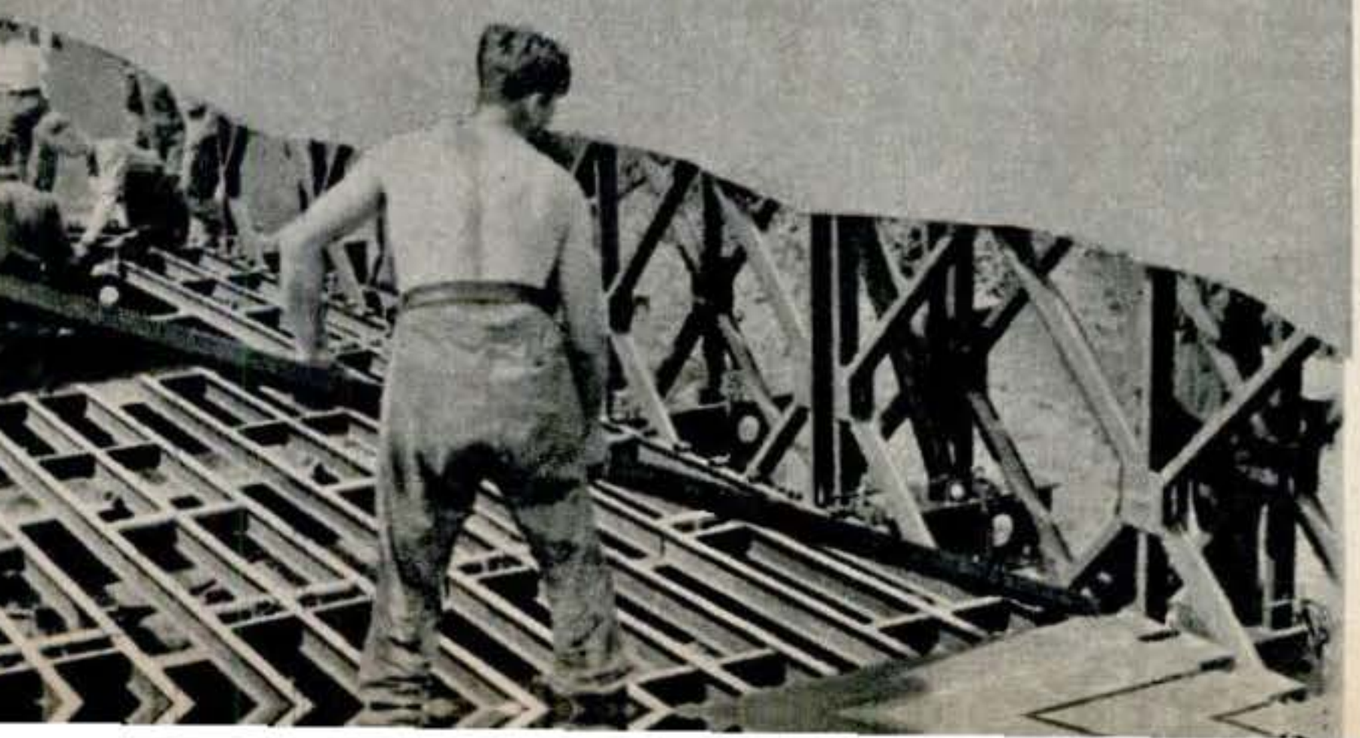
Leonardo, alert to pick up new ideas from far corners of the globe, wrote: "This instrument is employed in the Indian Ocean in pearl fishing . . . he (diver) has goggles of frosted glass and cuirass (armor) with spikes set in front of it."

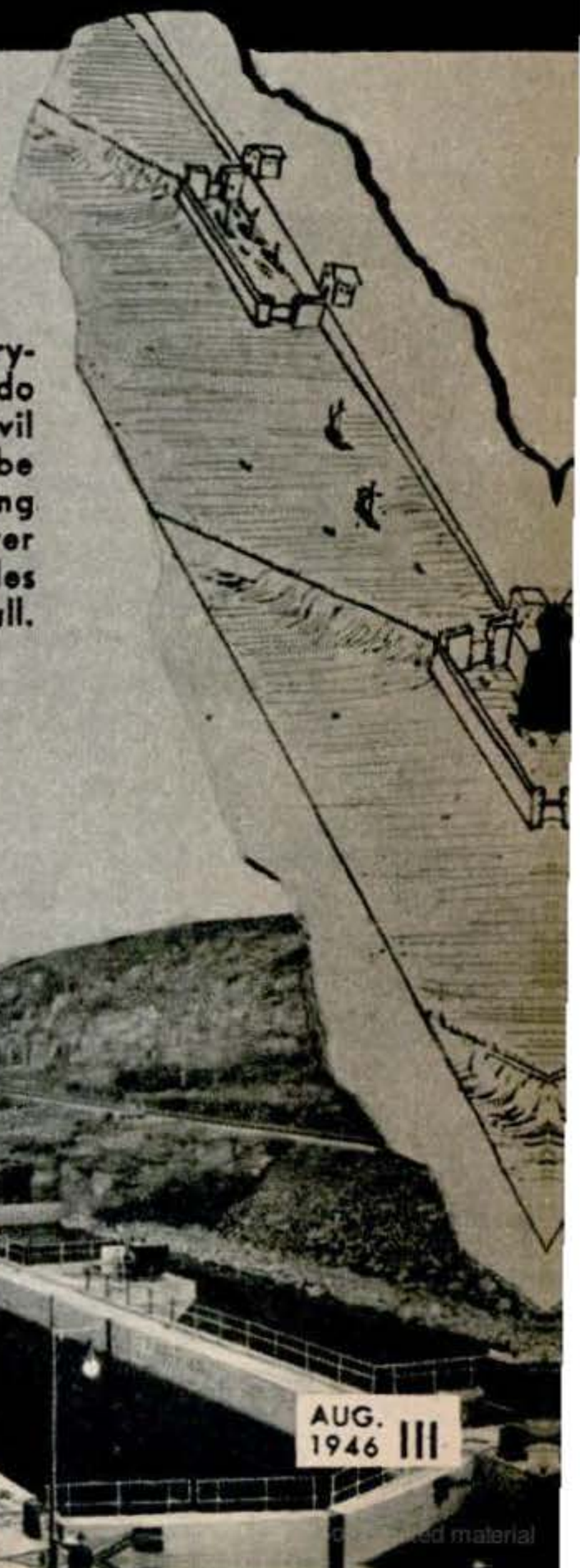


Leonardo warned that "this machine should be tried over a lake. . . . It is also necessary that the action of lowering the wings should be done by the force of the two feet, so that you can regulate the movement and preserve your equilibrium. . . ."

Also, to the Duke of Milan, he wrote: "I have plans for bridges, very light and strong and suitable for carrying very easily, with which to pursue and at times defeat the enemy; and others solid and indestructible by fire or assault, easy and convenient to carry away and place in position. And plans for burning and destroying" the enemy's







On top of everything else, Leonardo was a skilled civil engineer, as can be seen in his drawing of a tumbling river with locks at sides of each waterfall.

Sketches from "Drawings of Leonardo da Vinci," by courtesy of Reynal & Hitchcock.

Engineering better bananas

Giant water towers spray 3.3 acres of banana plants at once during the dry season in Central America. Diesel engines supply the pressure.

WE HAVE bananas again today chiefly because a scientific attack was made on the dreaded *sigatoka,* leaf-killing disease, that threatened Central American groves a few years ago. The battle still goes on. Diesel-engined pumps and a network of pipes covering miles of plantations squirt Bordeaux mixture (copper sulphate, lime and water) on the plants. A second complicated set of pipes and pumps channels water to 25-foot towers that sprinkle the equivalent of two inches of rainfall a week. The old method of irrigation through canals, ditches and furrows is going out.

On 25,000 acres of what were Guatemalan malarial wastelands in 1934, United Fruit Company keeps 7,000 natives busy and sometimes bewildered at the kind of work that makes modern banana growing a feat of agricultural engineering. The company now has some 50,000 horsepower in Diesels busy on its many farms in Central America.

Radio, too, comes into the picture—at harvesting time. Definite loading orders are transmitted by radio from United Fruit's head office in the United States to the central office of the tropical division, before a steamship arrives at the loading port. In due course each district headquarters receives cutting orders, based on the capacity of the ship and the estimated quantity of available fruit of the required grade, and in turn gives the necessary instructions to the farms. Then each farm overseer makes his allotment to the individual sections and the cutters, and sees that everything is in order to meet his schedules.

In spite of scientific improvements, some primitive methods must be retained. Native workers still plant the rhizomes (rootstocks), cut down the bunches, and clear away the stalks by hand.

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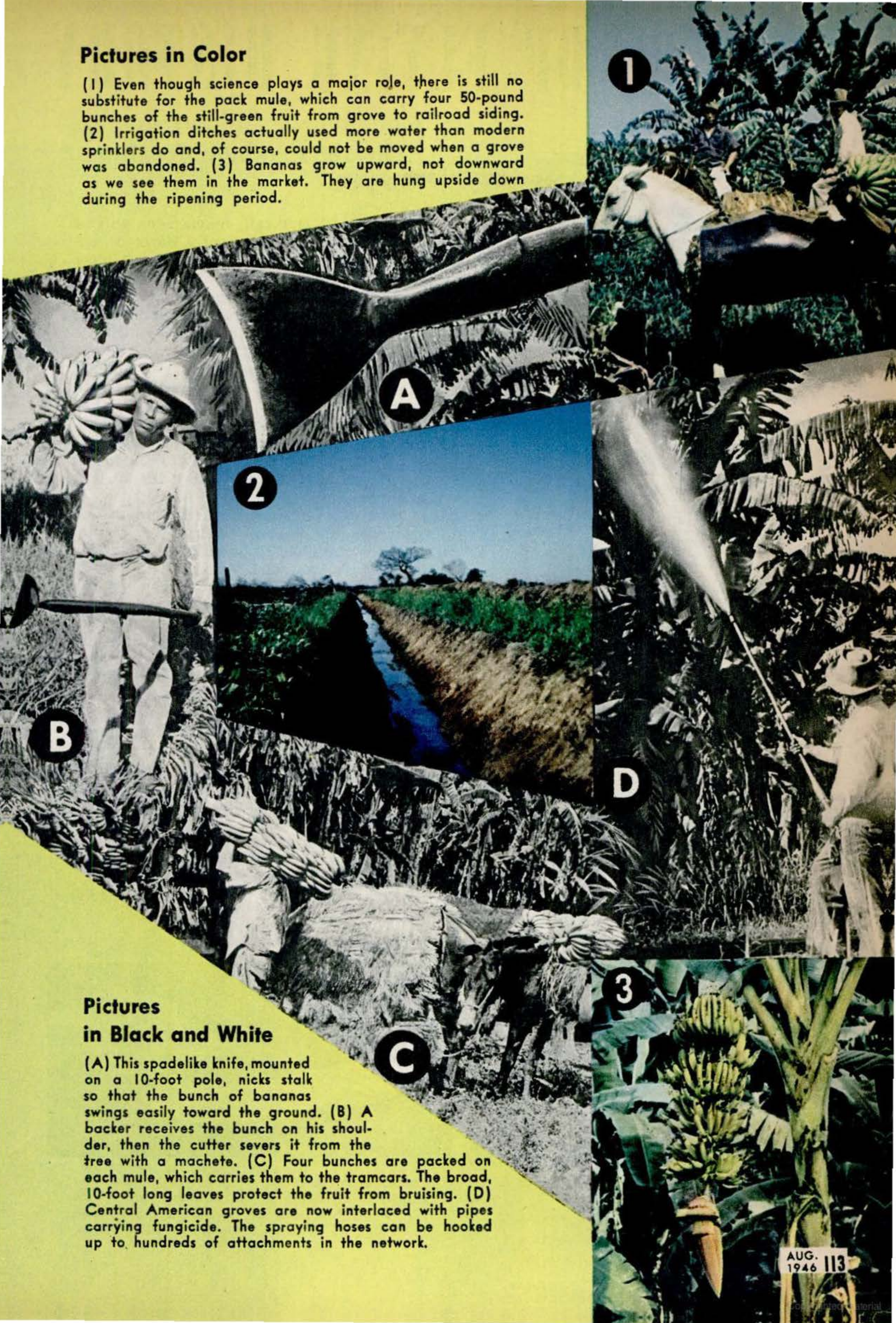
Pictures in Color

(1) Even though science plays a major role, there is still no substitute for the pack mule, which can carry four 50-pound bunches of the still-green fruit from grove to railroad siding. (2) Irrigation ditches actually used more water than modern sprinklers do and, of course, could not be moved when a grove was abandoned. (3) Bananas grow upward, not downward as we see them in the market. They are hung upside down during the ripening period.



Pictures in Black and White

(A) This spadelike knife, mounted on a 10-foot pole, nicks stalk so that the bunch of bananas swings easily toward the ground. (B) A backer receives the bunch on his shoulder, then the cutter severs it from the tree with a machete. (C) Four bunches are packed on each mule, which carries them to the tramcars. The broad, 10-foot long leaves protect the fruit from bruising. (D) Central American groves are now interlaced with pipes carrying fungicide. The spraying hoses can be hooked up to hundreds of attachments in the network.

Retakes OF FLYING HISTORY

Montgomery's gliders, dating from 1883, rebuilt for film.

Montgomery's second glider, built in 1905, cuts loose from launching balloon at 4,000 feet.

SOMETIME this fall, movie fans will be able to see a film about a derbied gentleman who is reputed to have flown gliders more than 60 years ago. What the film, "Gallant Journey," will *not* show is what the property men of Columbia Pictures had to resort to in order to reproduce authentic gliders dating back to 1883.

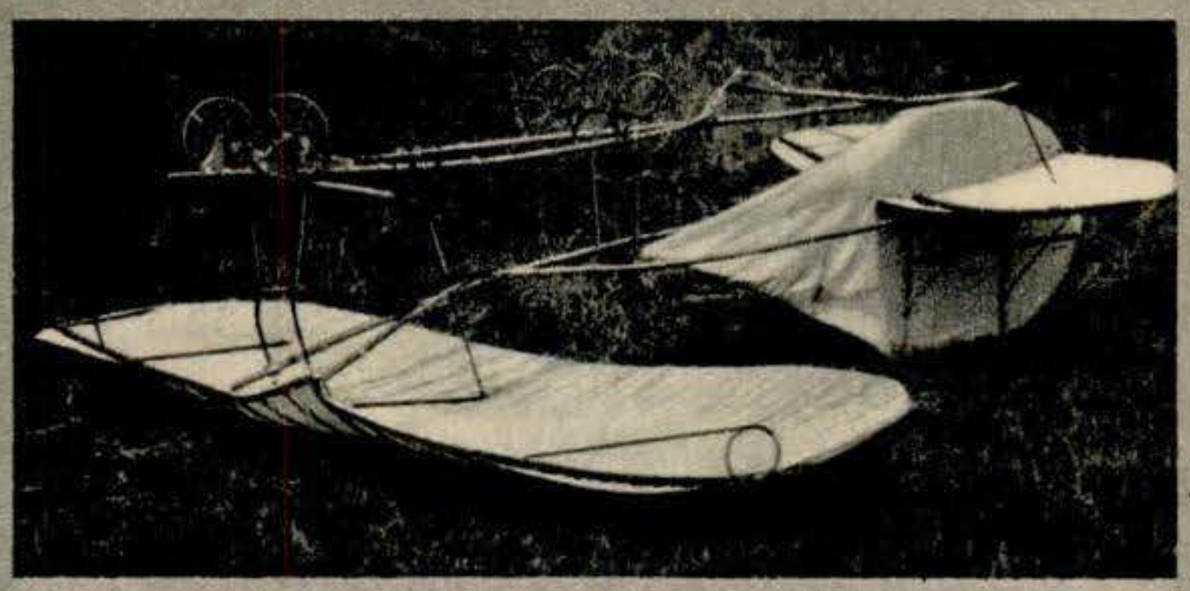
"Gallant Journey" is the story of John J. Montgomery, credited by his partisans with being the first man to make a flight in a heavier-than-air device incorporating a controlled wing. They insist that he flew eight years before the immortal Otto Lilienthal and almost two decades before the Wright Brothers.

Three different Montgomery gliders will appear on the screen. Each of the fabric-and-wire craft had to be built in miniature, then in full scale, and tested.

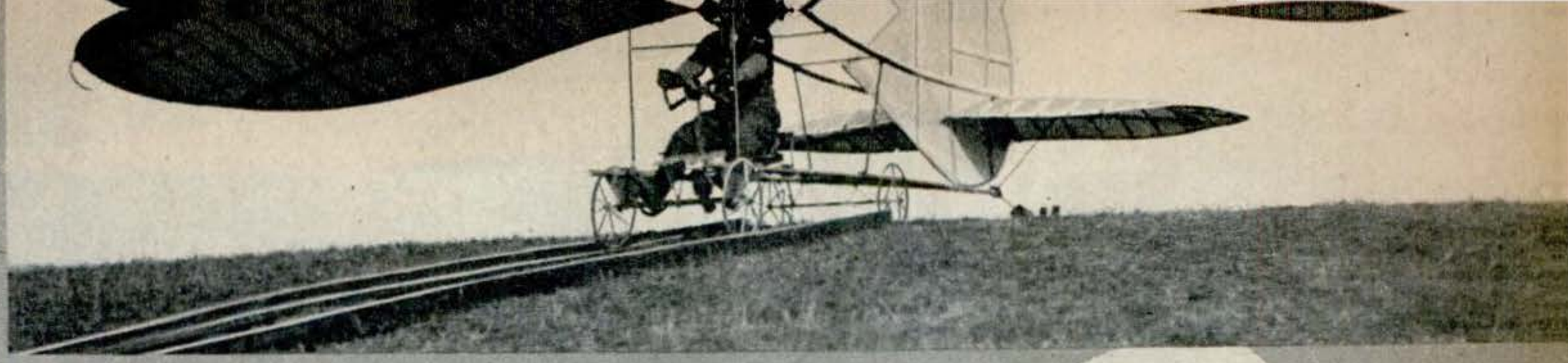
Even so, Don Stevens, well-known glider flier, crashed from 15 feet when a freak wind doubled his climbing speed on a tow rope. Both wings folded back like an accordion. On another flight Paul Tuntland mushed heavily for 50 feet onto a slab of concrete because the machine's center of gravity was too far back.

Stan Polich, engineer for the Radioplane Company, builders of small target aircraft, drew the assignment of recreating the gliders. Drawings and photographs showed that the glider of 1883 and one built in 1905 were types in which the pilot hung from the fuselage by his arms. A 1911 version was a primitive sailplane with a seat. All were controlled by "warping" the wing tips.

Polich did a preliminary job on the 1883



Wreckage of the glider in which the pioneer flier crashed to his death in 1911. At left: His widow visits Glenn Ford, star of "Gallant Journey," and Janet Blair on set where the film is being made.



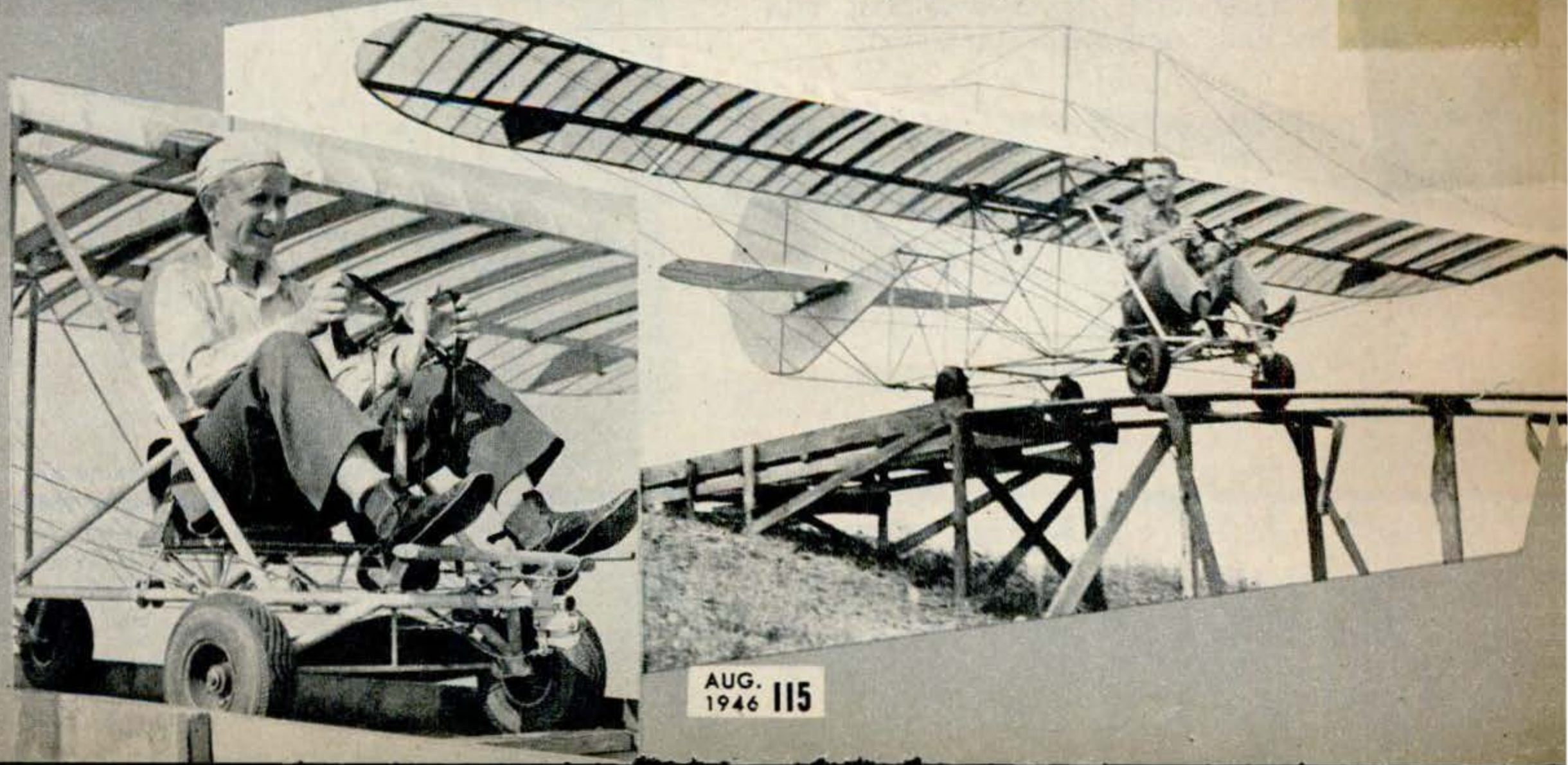
In 1911 flight tests near Santa Clara, Calif., Joseph C. Vierra took turns with Montgomery at piloting the latter's third glider. Note the control Vierra is gripping; it is similar to the cockpit wheel used in airplanes today.

Successfully launched by automobile tow in prelocation tests, this 1946 version of Montgomery's 1883 glider proved out his theories of lift from curved (or cambered) wings.

Close-up of a pilot of one of the rebuilt gliders reveals the control stick strapped to his back for safety's sake in filming.

Feet dangling, Paul Tuntland, one of the fliers doubling for Glenn Ford in the film of Montgomery's life, pilots a reproduction of the 1883 glider. He is shown in free flight.

Ready for a movie launching from a wood runway that duplicates the one Montgomery used.



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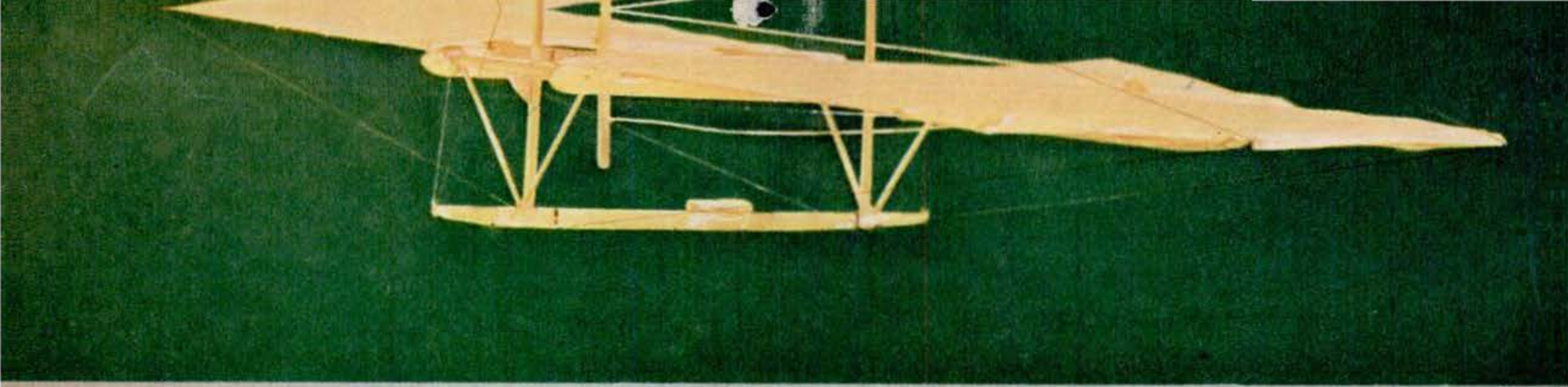


Montgomery first flew at Otay Mesa, Calif., hanging by his arms from the fuselage of a glider of which this model is a copy. He controlled the glider by bending its wing tips.

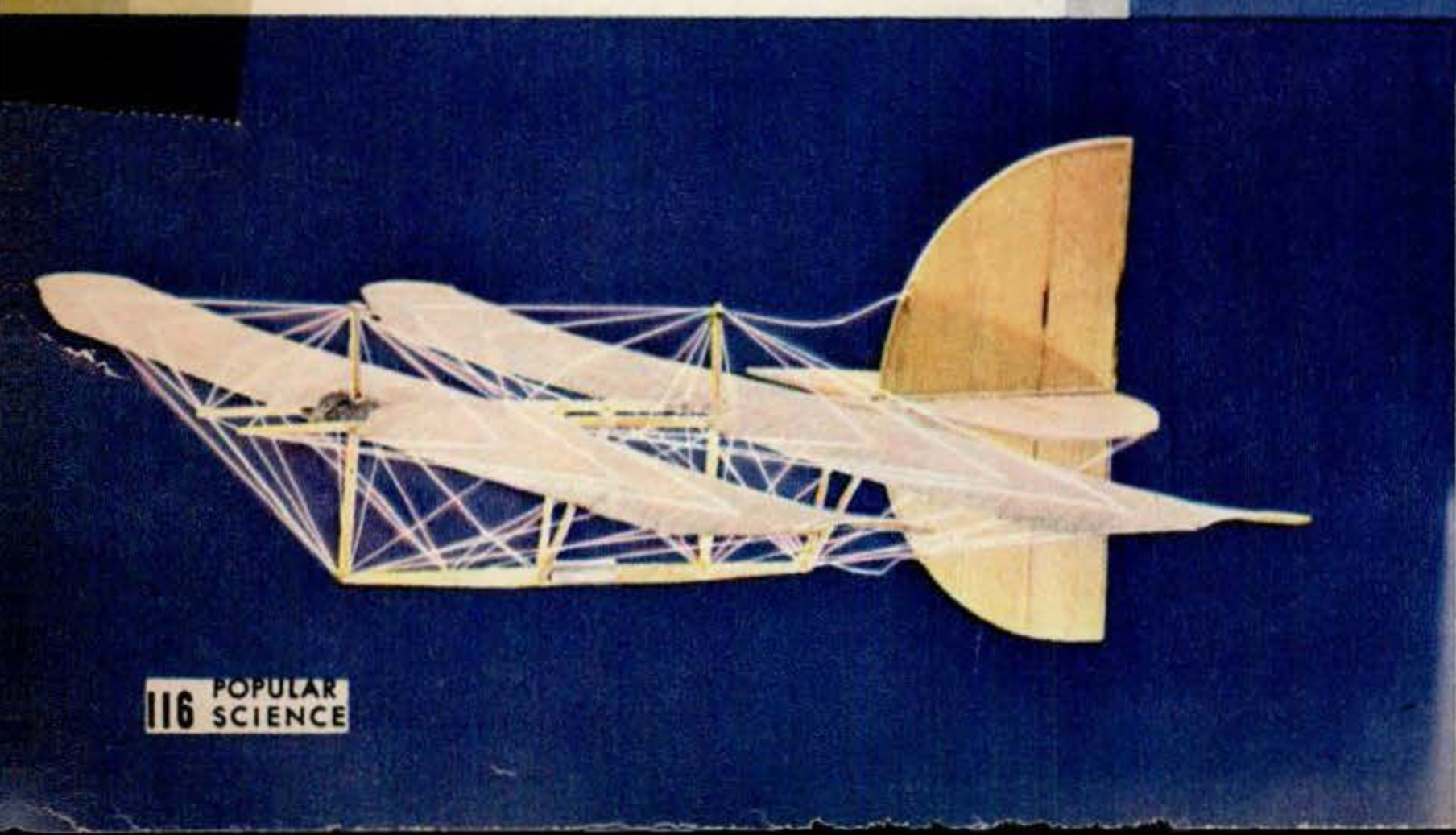
glider. Then the pilots, who were to do the actual flying for the star, Glenn Ford, walked in. They wanted regular aileron control surfaces. They didn't like the warping business. Polich added ailerons, and a vertical tail surface for directional control. He installed more wires for strength. He used welded tubing for the gliders' structures to assure strength and built in metal landing skids in place of wood and bamboo.

Some liberties also were taken with the second glider, with tandem wings. Polich followed the dimensions to the inch, but he braced the wings and put ailerons on both sets of wings. The aileron control was put behind the pilot and was strapped to his body to hide it from the cameras.

Polich worked from a picture of the third glider, taken after it had crashed, carrying Montgomery to his death in 1911. Montgomery used a control wheel—so Polich borrowed one from a P-38 cockpit.

Director William Wellman, a World War I flier himself, is making the film to rescue Montgomery from obscurity. The Southern California barn-loft scientist learned aeronautics from watching buzzards fly and from elementary texts.

Tandem glider's wings were covered on top only. Its closely spaced ribs and wire bracing are evident in the model that Glenn Ford holds.



Model of Montgomery's second glider shows the vertical tail, added to carry out Director Wellman's order: "Make them authentic, but safe."

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A BET FACTORY

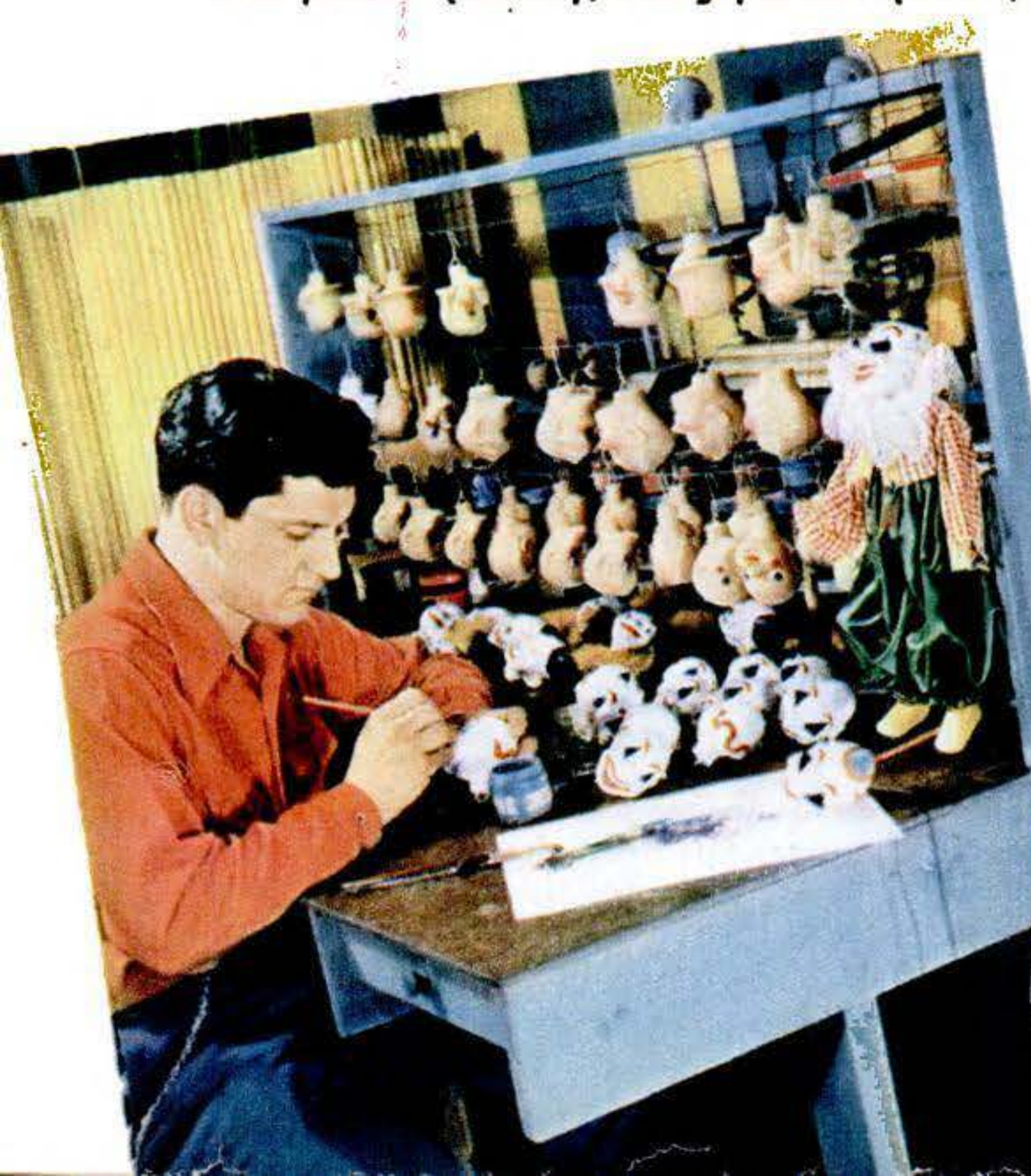
A BET spurred Bob Baker into starting a puppet factory when he was invalided out of the Camouflage Battalion of the Army Air Corps two years ago. His only capital was his mustering-out pay.

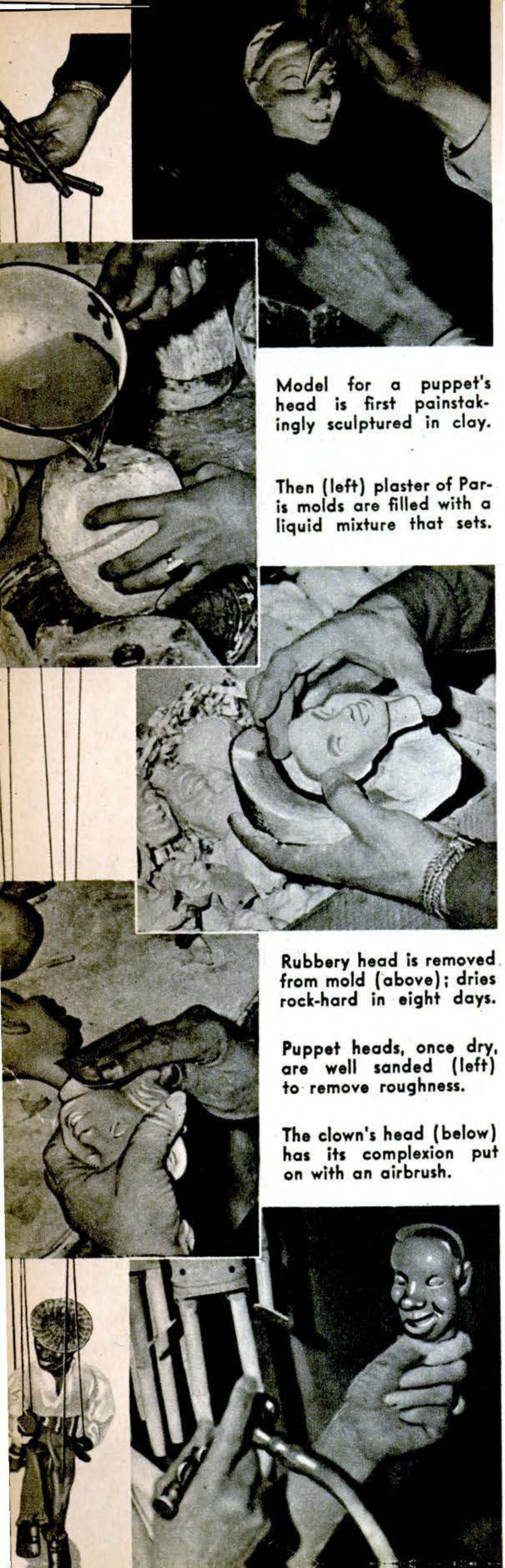
"I'd OK a loan if it were for anything sensible," one banker told him, "but not for puppets."

Baker managed to rent a small abandoned garage in Los Angeles in July 1944, and moved in a used band saw, table saw, drill press, and improvised work tables. Since then, he and a small but growing staff have made and marketed more than 15,000 puppets.

Koko, a red-nosed clown inspired by a circus poster, was the 22-year-old manufacturer's first product. Baker was able to sell this model at a wholesale price low enough to compete successfully in the Christmas toy market. Koko was a persuasive salesman and the wartime toy famine was acute; Baker's supply was gone in a week and frantic reorders kept him and his ex-GI crew busy up to Christmas Eve. Now, Bob Baker's Marionettes, as they are called commercially, are available in 22

Bob Baker's marionettes along the production line: being shaped and jointed (above), being painted (below, left), and finished.





Model for a puppet's head is first painstakingly sculptured in clay.

Then (left) plaster of Paris molds are filled with a liquid mixture that sets.

Rubbery head is removed from mold (above); dries rock-hard in eight days.

Puppet heads, once dry, are well sanded (left) to remove roughness.

The clown's head (below) has its complexion put on with an airbrush.

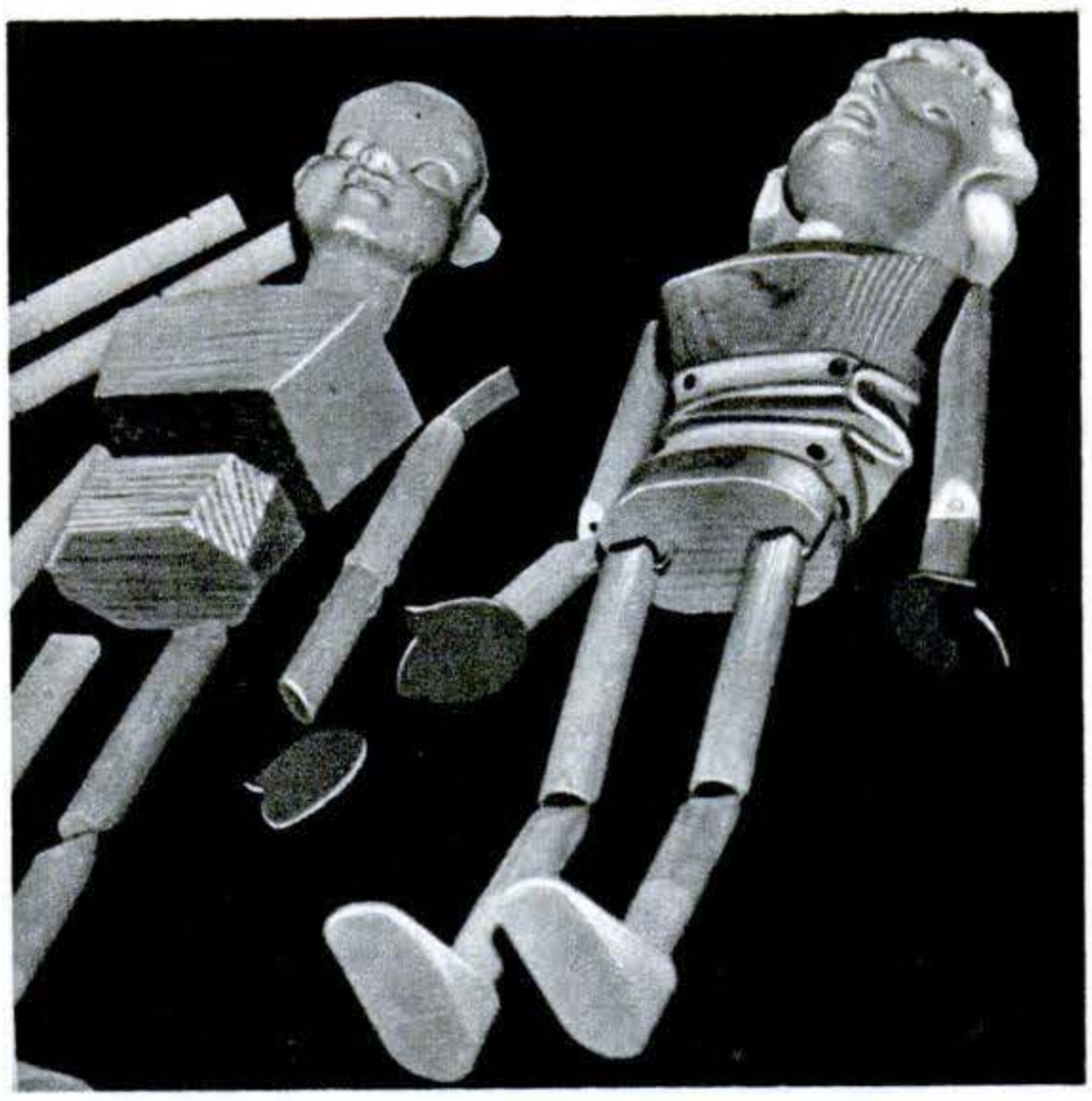
models and their makers have had to move to larger quarters.

Baker saves construction time by mechanical short cuts and by stylizing some of the body parts. Only professional puppeteers, for example, demand lifelike hands for their puppets—a job that keeps a skillful carver busy for a day. Baker die-stamps hands from masonite in a few minutes.

Jigs—142 in all—are important in the construction of these puppets. The time it takes to fashion the 16 small pieces of wood that make up a puppet's body has been reduced by allocating several jigs to each part. It takes one jig, for example, simply to shape the top of a two-inch foot. Jointing each section of the arms, legs, and torso has been simplified by using jigs in combination with a drill press.

Baker strings all the puppets himself, after they have been put together and dressed. This process requires great exactness; if only one of the eight strings running to the horizontal controls is irregular, the puppet will be off balance.

Baker also makes marionettes for professional puppeteers—much more expensive ones, with movable eyes and mouths and other special features. And he has a group of puppets that he calls the Baker Stock Company. These rent to movie studios for as much as $500 a week.



Puppets in the rough, without paint or costumes. The one at the right has been strung together with thin strips of leather, which Baker prefers because it assures the most lifelike body movement.

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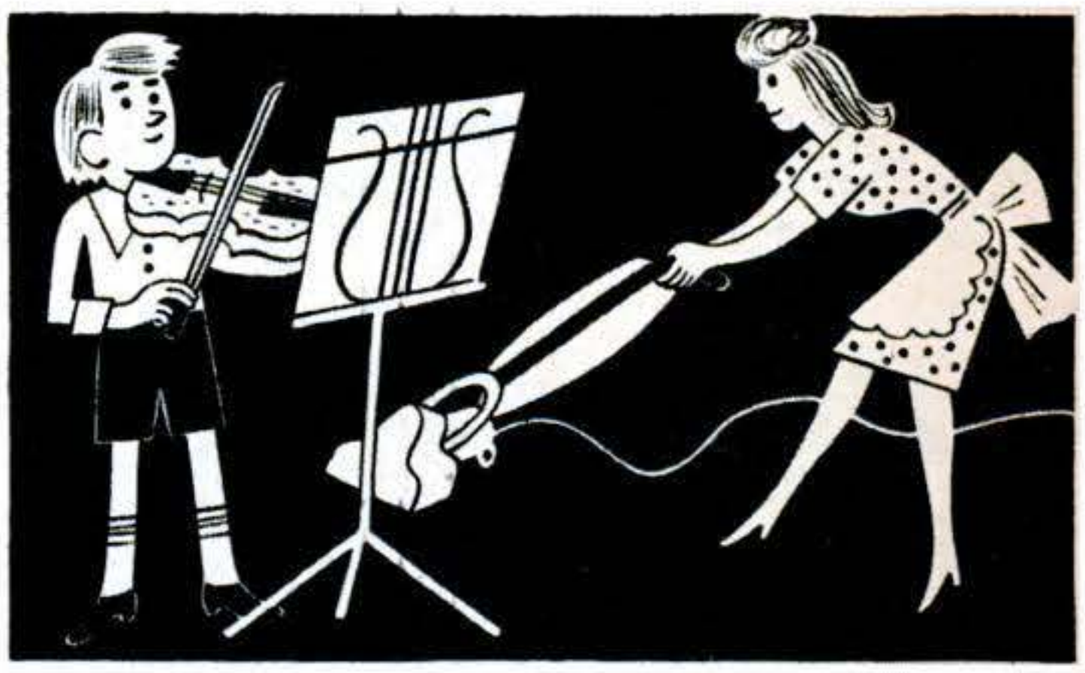
I'd like to see them make

Everybody has his own pet idea of some gadget he would like to see in general use. What is YOURS? *Popular Science Monthly* will pay five dollars for every such suggestion that its editors decide to publish.

Nonmisting glasses. Some device, maybe a coating, to prevent the lenses from clouding in changes of temperature. Suggested by Frank Standohar, Hibbing, Minn.



Noiseless vacuum cleaner. Joseph Palmieri, New Haven, Conn., thinks one ought to be produced that doesn't sound as if a B-29 were taking off.

Safer stem-winders. A device that would stop the winding of a watch when it is complete, thus protecting the mainspring. Howard Calder, New York, suggested it.

"Nuts to you" horn. On the back of her car, Myra Ann Bloxom, Elmhurst, Ill., wants a horn to answer twice as loudly the honks of impatient people behind.

Obedient radio. From your easy chair, you would simply call the letters of the station you want, and the radio would oblige. Idea is from Leon Wolder, New York.

Luminous license plates. To find your parked car easily at night, I. Edinger, Brooklyn, N. Y., suggests covering the plate numerals with phosphorescent paint.

Cartoons by SYD LANDI

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Spark-Plug Colors Tell Engine's Health

SPARK PLUGS take an engine's temperature much the same way a clinical thermometer takes the body temperature. Many hidden troubles reveal themselves by the effect they have on the spark-plug nose, the color of which tells how the plugs have been operating—hot, cold, or normal. To examine plugs, run the engine at normal speed, then stop. Remove plugs and compare with the pictures below to see what the plug-nose colors mean. (Photos courtesy of the Electric Auto-Lite Co.)

PLUGS ARE TOO HOT

PLUGS that look like these are robbing the engine of power. They can cause preignition, knocking, and missing, especially at high speeds and on hard pulls. The trouble may be in the plugs themselves. Other faults may be loose plugs, improperly adjusted ignition timing, improperly seating valves, excessively lean mixture.

Nose and insulator badly burned. Electrodes show excessive erosion.

Dark-colored deposits on nose and excessive electrode erosion.

Early stage shows only few spots on nose. Electrode erosion normal.

PLUGS ARE TOO COLD

PLUGS that look like these are wasting gasoline and oil. A coating of carbon or sludge on the plug tip can foul the plug, causing it to miss or short out. Plugs may be too cold for the engine. Other causes of trouble may be anything that lets too much oil in the cylinders—loose rings, worn rings, too rich a fuel mixture.

Black accumulation of oil and carbon on nose and around shell.

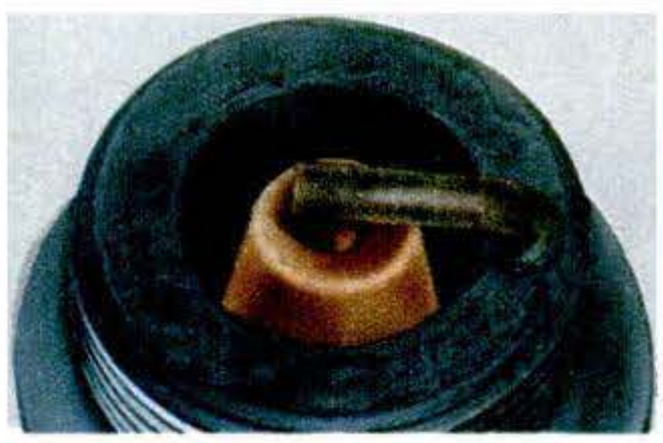
Dull black film of carbon gives sooted appearance to nose, shell.

Sludgy oil and carbon fill gap between the shell and insulator.

PLUGS ARE NORMAL

OPERATING temperatures in each engine differ, even in the same model engine. A plug of correct heat range holds just enough heat to burn away carbon on the nose. All other heat is carried to the block and water jacket of engine. Spark plugs like these three are right for the engine. About all they need is a good cleaning.

Rusty deposits darkest at firing tip. Erosion only at spark gap.



Powdery grayish tan deposits on the nose, electrodes, and shell.

Powdery deposits on nose and electrodes. Erosion at spark gap.

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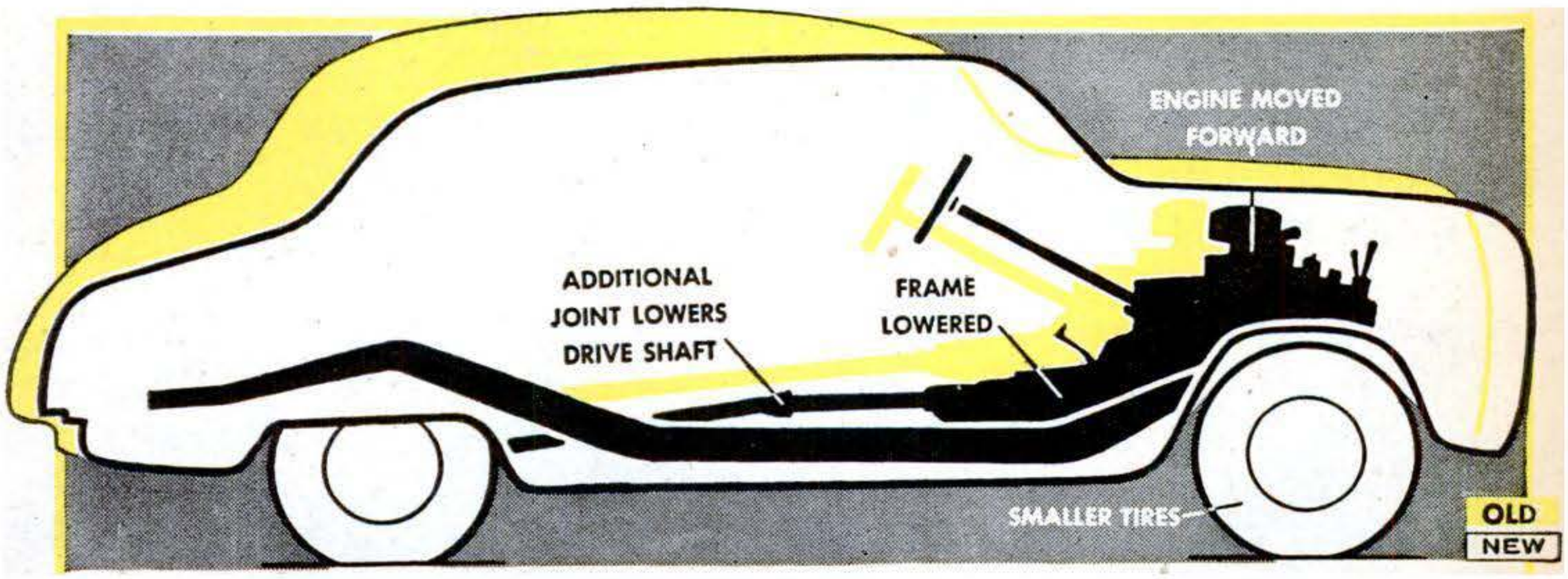
FIRST '47 CAR on the Road

Radically new Studebaker is lower, broader, smoother riding, safer.

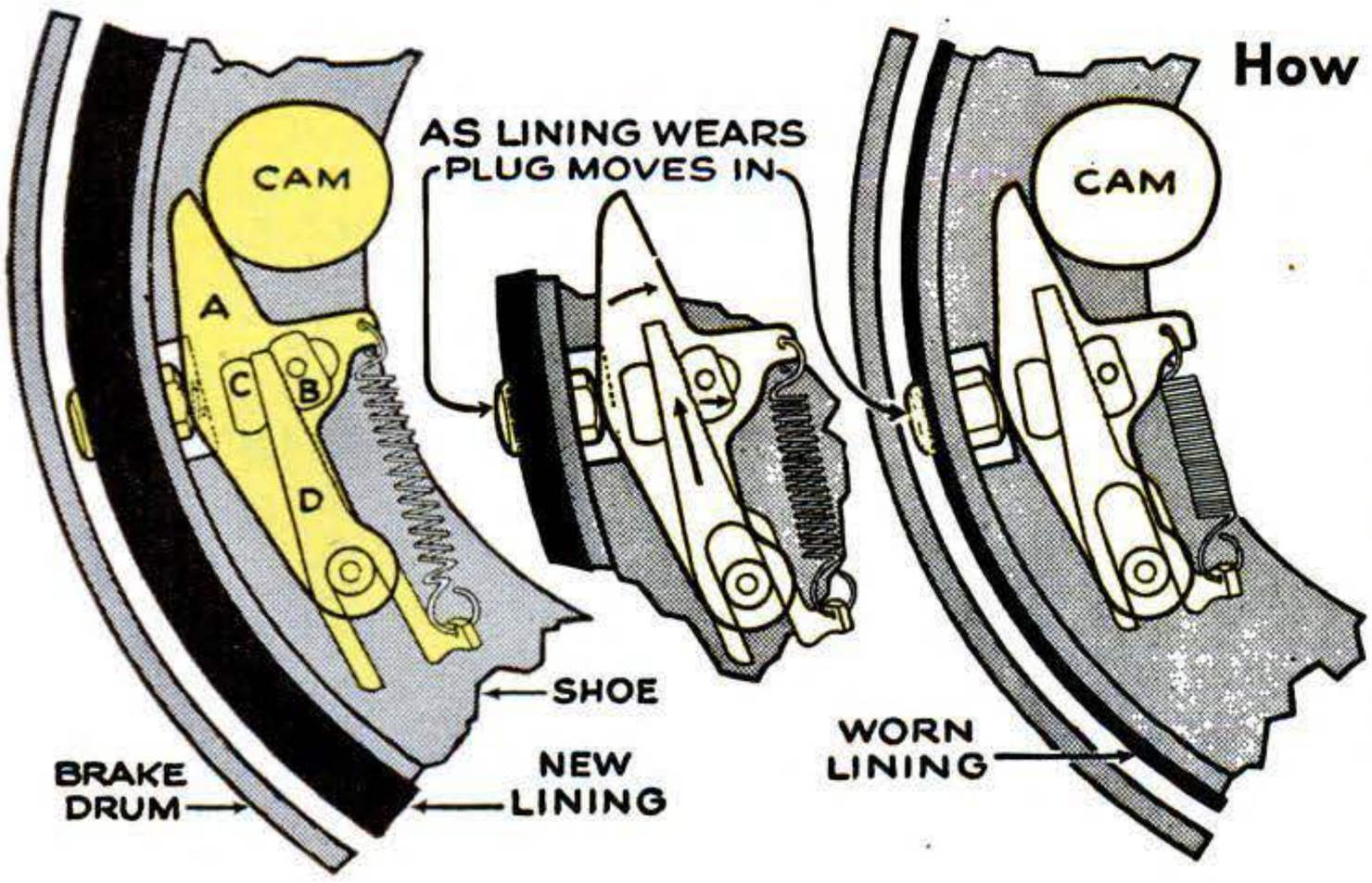
STUDEBAKER leads the parade of truly postwar automobiles with 1947 models that hug the road for greater stability, bulge at the sides to absorb the fenders, and have self-adjusting brakes (diagramed below). The designs, by Raymond Loewy, were tested in a wind tunnel (PSM, June '46, p. 214). The engine and power train are the same as in the latest previous models, but changes under the body skin are many.

Smoother riding is gained largely by a scientific redistribution of weight. The engine has been moved forward nine inches; the center of its weight now being cushion-mounted virtually over the front spring suspension. And the passenger compartment has been pushed 11 inches farther forward to a position 19½ inches ahead of the rear axle. The front-axle suspension has been revised and both the center of the frame and the center of gravity lowered. A two-section drive shaft has a universal joint in the center of the chassis, making a rear-floor tunnel unnecessary.

In addition to the new brakes, a stronger box-section frame has been added. On some models the windshield area has been increased as much as 144 square inches.



Former Studebaker lines and arrangement of chassis are shown in color; '47 model in black.



How New Brake Works

Parts A and B are connected to plug; C to brake shoe. D rides between the two lugs. Cam, attached to backing plate, rides through slot in shoe. Now follow drawings through three stages of lining wear: As lining thins, plug and B move in and tilt A. Wedge D springs up to fill in between C and B. Tilt of A against cam moves brake shoe forward.

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Storm Warnings from WAVES

Wartime study of ocean's behavior meant smooth beachhead landings, now forecasts coming of hurricanes and typhoons.

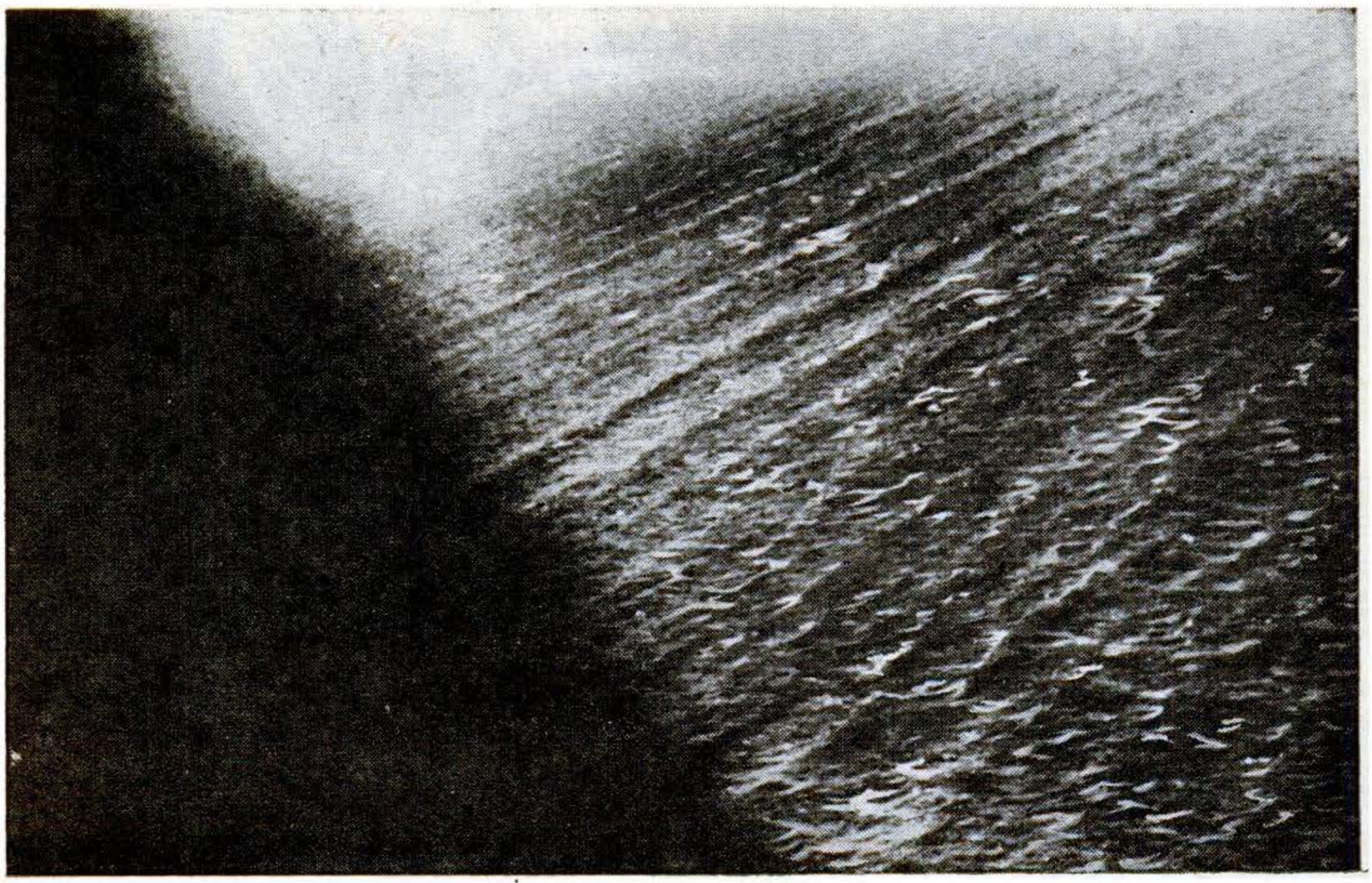
METEOROLOGISTS and oceanographers, primed by intensive wartime study, today have many practical answers to the fanciful question, "What are the wild waves saying?" Approaching typhoons and hurricanes can now be predicted by heeding the warning of the waves, which frequently run ahead and announce a storm's coming. Heavy swells can be forecast and preparations made to protect ships and property ashore. Transoceanic plane pilots can be told in advance what conditions to expect if forced down and whether rescuers will arrive by air or surface vessel.

From weather maps the meteorologist is now able to find the surface wind velocity and determine the fetch (sweep) and duration of the wind. He then can tell the height and frequency of significant waves. An 18-knot wind and a fetch of 300 miles produce waves eight feet high that will pass a given point every 6.3 seconds. A 32-knot wind and the same fetch produce 20-foot waves that roll by every 8.4 seconds.

Much of the basic research about the ocean was done with Army and Navy help by Dr. H. U. Sverdrup, director of University of California's Scripps Institution of Oceanography, and directly aided amphibious operations during the war.

WHAT DID THE PLANE PILOT READ FROM THIS PICTURE OF A HURRICANE SWELL?

If the pilot knew his oceanography, he realized the swells were moving to his right, the waves were rolling toward the top of the picture, and that he was heading in the general direction of the storm. Schematic drawing on opposite page tells the story.



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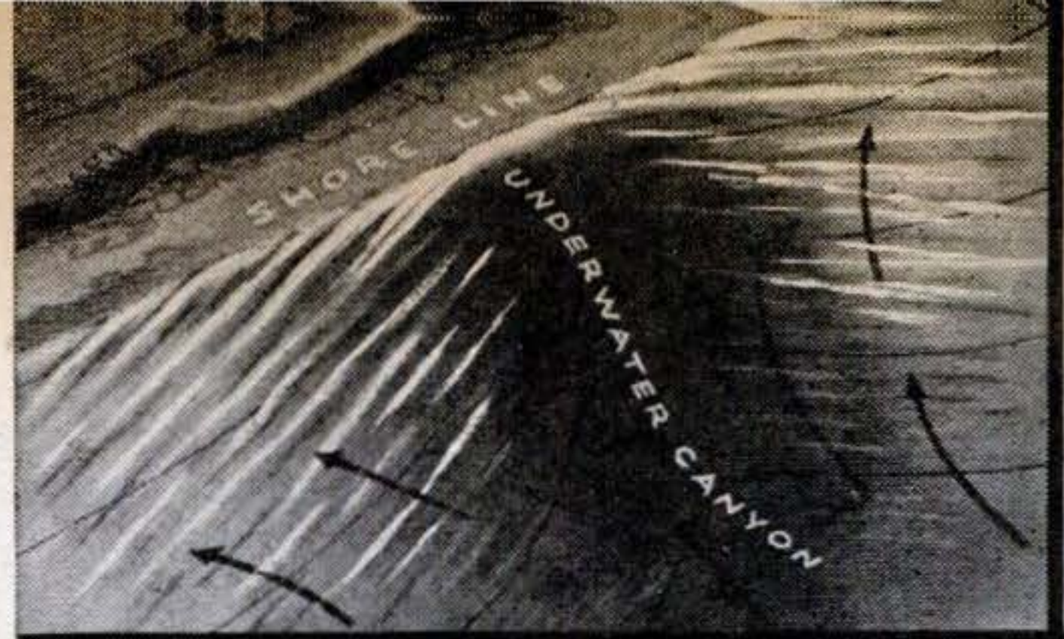
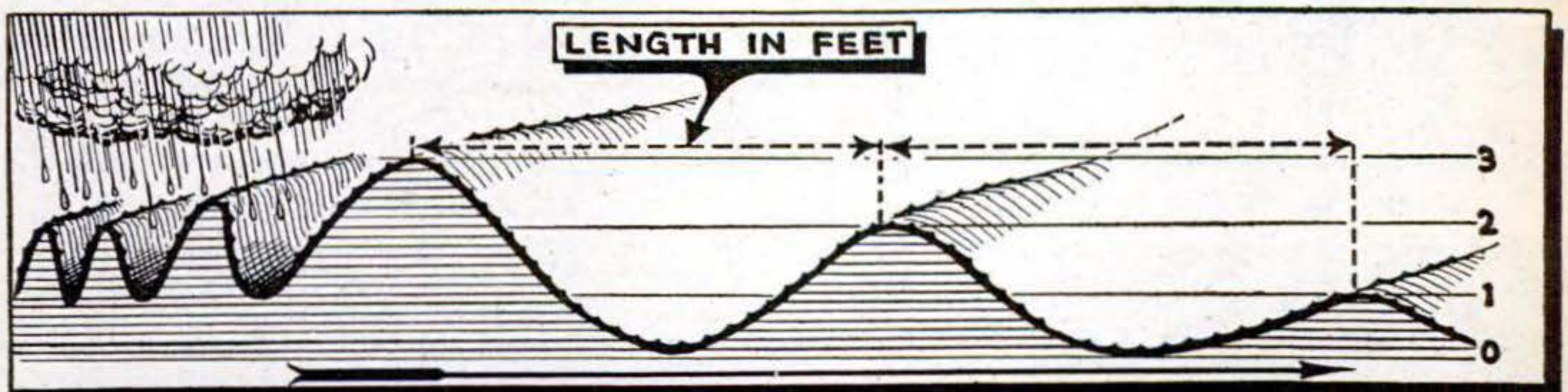


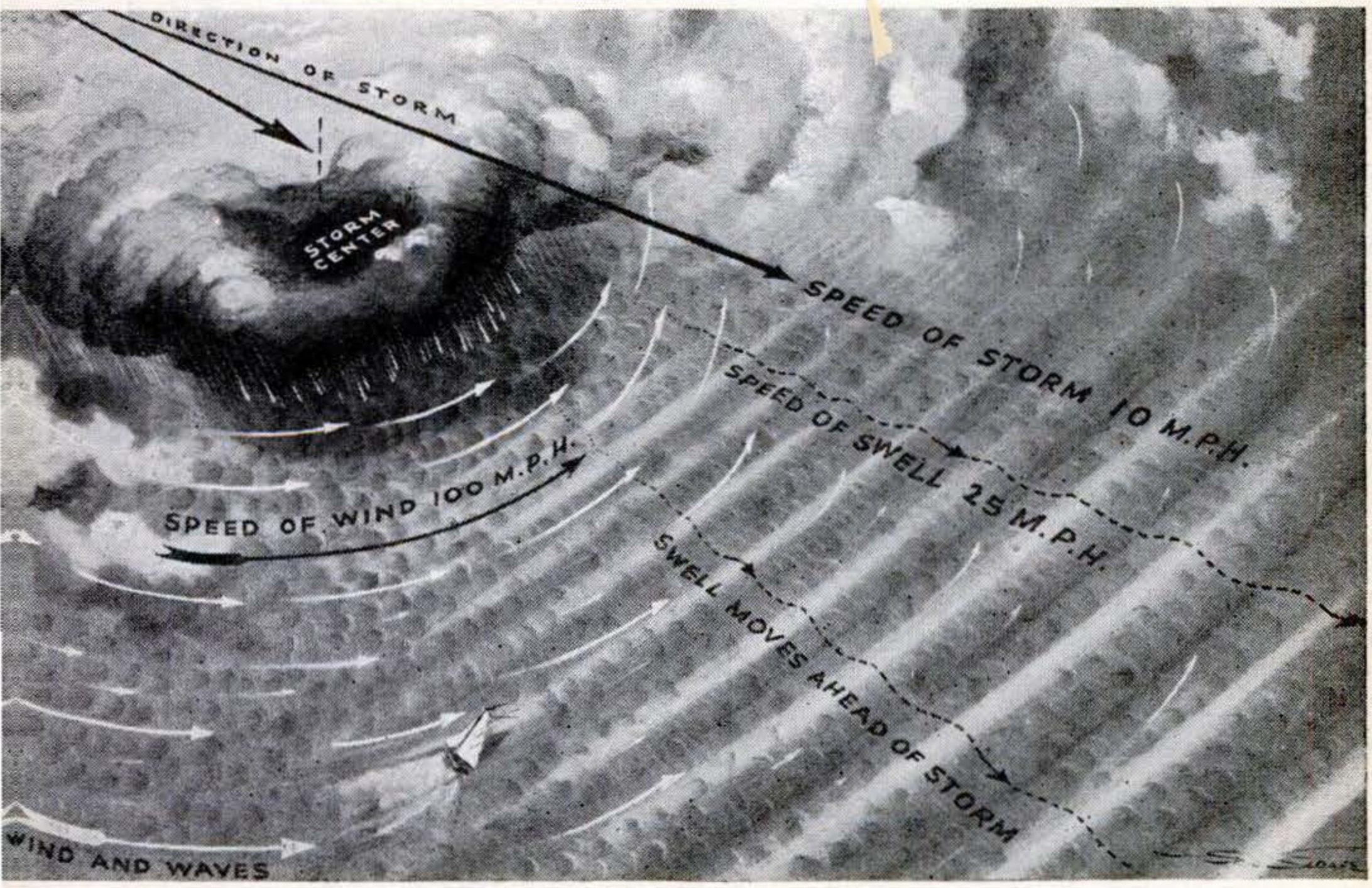
Underwater canyons cause waves to fan out, stretching crests and cutting down height.

Underwater ridges have opposite effect. Waves are slowed, but a high, heavy surf rolls in.



A swell loses one-third its height each time it travels the number of miles equal to its length in feet. Thus, a 30-foot swell (crest to crest) diminishes to 20 feet in traveling 30 miles.

Wind and waves move with the storm circle, but ocean swell radiates ahead as a warning of the disturbance. Waves break in the direction the wind is blowing. Wind starts and speeds up waves in two ways: by direct push at the water level and by brushing over the surface, causing skin friction. The added impetus drives the waves faster than the wind. Knowing certain basic data, a plane pilot can estimate the height of swells, barely perceptible from the air but which may be 20 feet tall or more.



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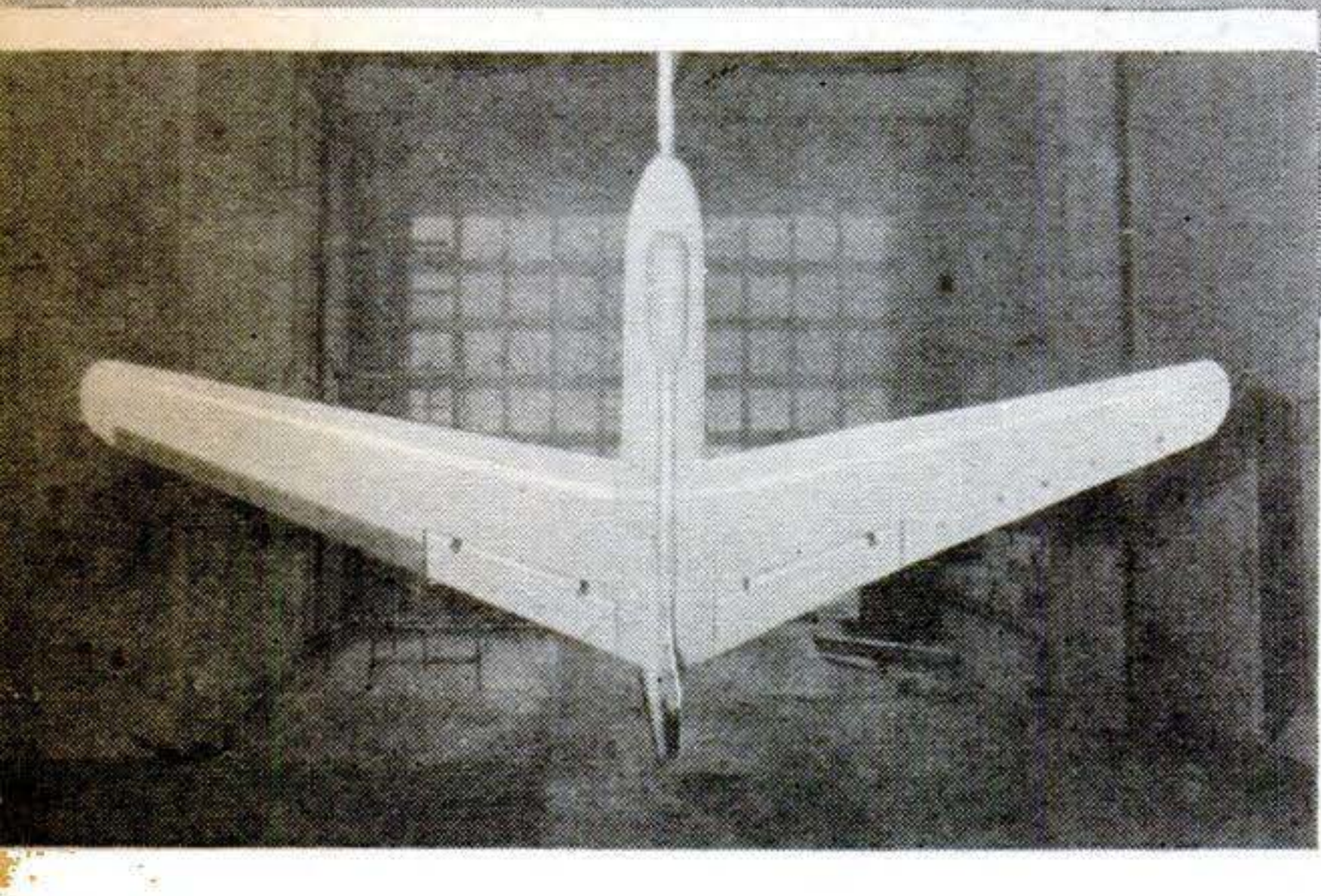
Gliding Gas Tank May Refuel Planes on Ocean Hops



The fuel-carrying XFG-1's unusual design is well displayed in the 1/4-size model at left. The full-size sky trailer (above) has a wing span of 54 feet, is 28 ft. 3 in. long and 14 ft. 9 in. high.

THE XFG-1, a high-speed, fuel-carrying glider of radical design, may help commercial air liners make longer overwater hops with more passengers than they now can carry. A 764-gallon "flying gas tank," Experimental Fueling Glider No. 1 was intended to refuel Tokyo-bound B-29s in flight but was still being tested when the war ended.

Rather than develop expensive new power plants to give the necessarily overloaded Superforts greater range, AAF engineers decided to produce a fuel-carrying glider that could be radio-controlled or piloted on a long mission. The load of gas would be transferred to the mother plane by fast-working pumps about halfway to the target and the aerial trailer would be towed empty from that point on. But since the cruising speed of a B-29 is about 250 m.p.h., and existing gliders were built to be towed at about 125 m.p.h., a new glider had to be designed. After considerable experimenting, the XFG-1 was evolved.

This craft looks more like a hindside-to flying wing than a traditional glider. The leading edge of the wing sweeps sharply forward, while the trailing edge extends in a broad V to within a foot of the tail of the ship. Thus, the need for a separate elevator surface was eliminated. The elevator surfaces are incorporated in the wing itself on the inboard side of the trailing edge. Because there is no individual tail unit, the stabilizer and rudder are unusually large to insure directional control and stability. The wing roots are attached well back on the fuselage, but because of the design and forward sweep of the wings, the center of lift is opposite the center of gravity.

The welded, aluminum-alloy gas tank is an integral part of the fuselage, and the nose and tail are bolted to either end of the tank. The cockpit is forward of the tank and enclosed by a bubble canopy, which will insure excellent vision if the glider is to be flown by a pilot. The craft has a tricycle landing gear that can be dropped off and steel runners are welded to the bottom of the tank for belly landings.

Whether or not this unorthodox-looking craft ever goes into active service in the skies, the Air Transport Service Command says: "It has been successful insofar as information derived from its construction and tests will be of future benefit to Army Air Forces design."

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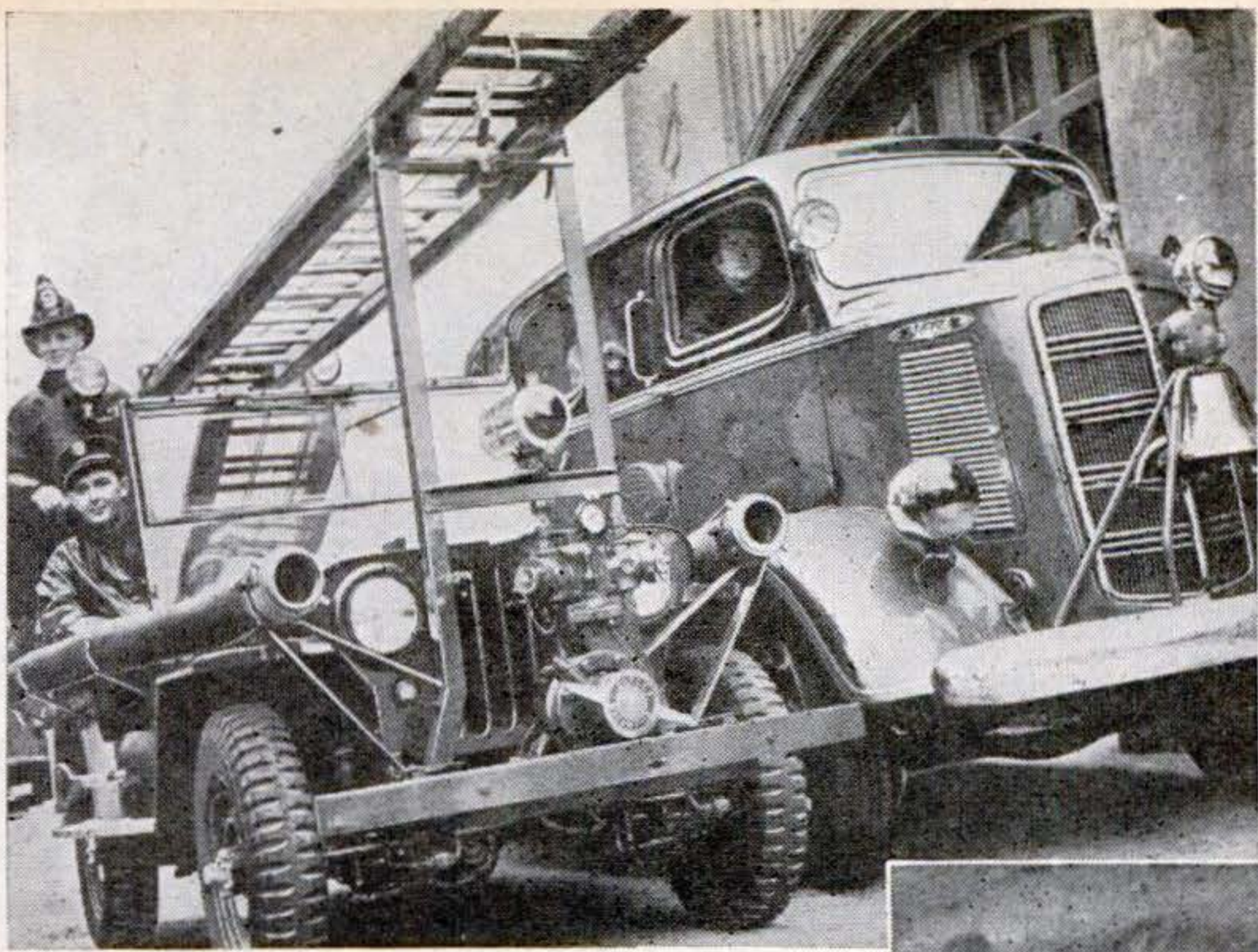
Volunteer Firemen's Jeep Takes Short Cuts



Looking like an elaborate toy beside a full-size vehicle of the Chicago Fire Department, a jeep fire engine (left), less than seven feet tall, nevertheless carries a five-man crew and fights fires effectively. Developed by Willys-Overland for small towns and industrial plants, it will soon go on sale for about $2,800. The big truck cost $11,000.

With all four wheels pulling, the jeep pumper plunges through a stream en route to a staged fire in Berkey, Ohio.

This blaze was put out in less than four minutes after an alarm brought members of the Berkey Volunteer Fire Department to the scene in their diminutive truck. The jeep raced across rough meadows for a quarter mile after leaving the nearest road, forded a brook and then pumped water from it to douse the fire.

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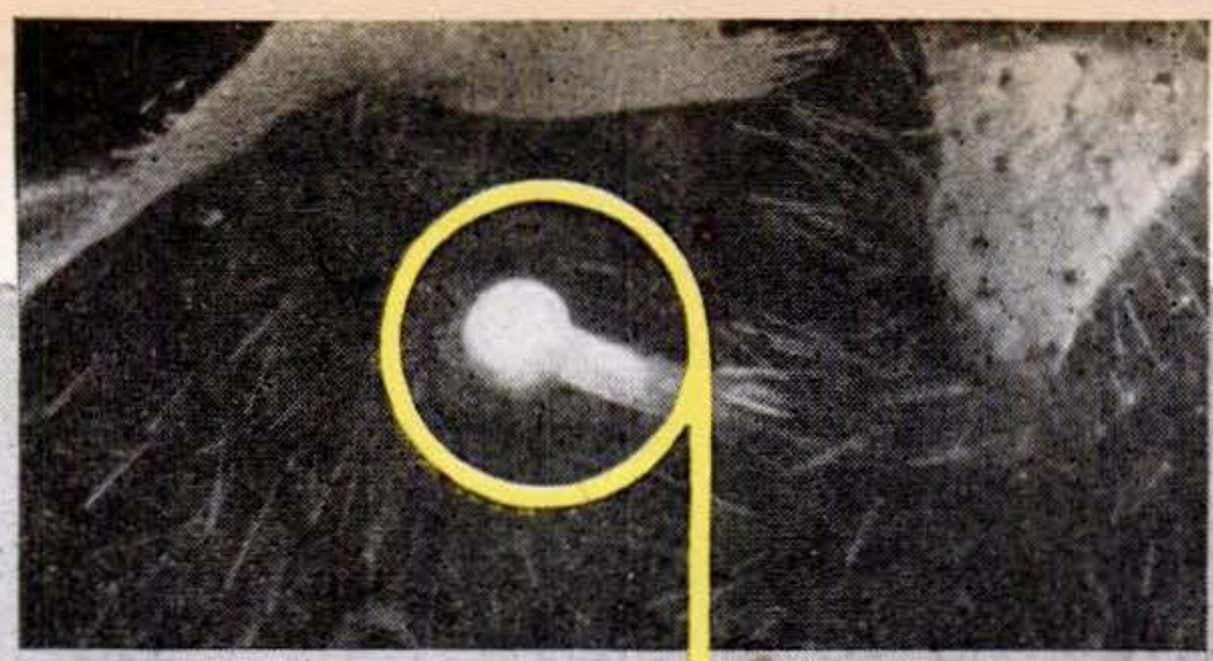
Close-up (right) of the model fly's left halter, or balancer. The knob on the end of this organ helps to produce inertia, or stability, as in the spinning gyroscope.



Giant Fly of Plastics shows Nature's Gyro

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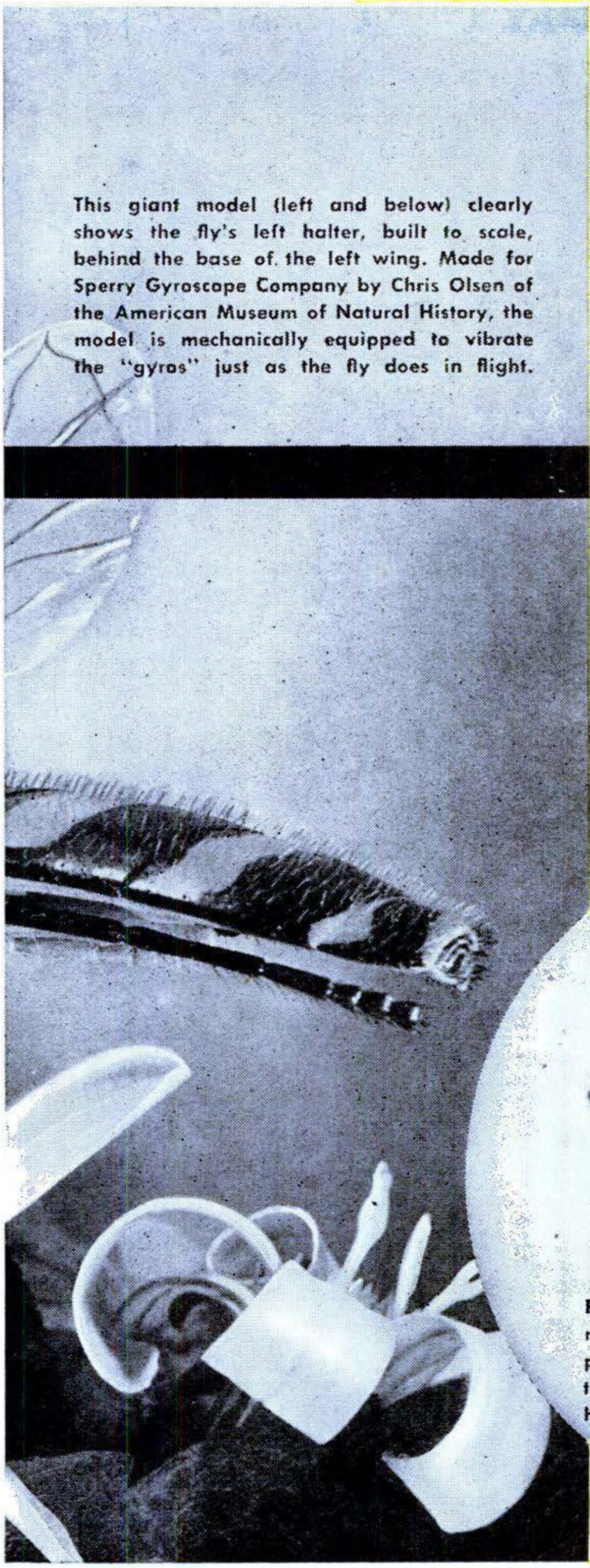
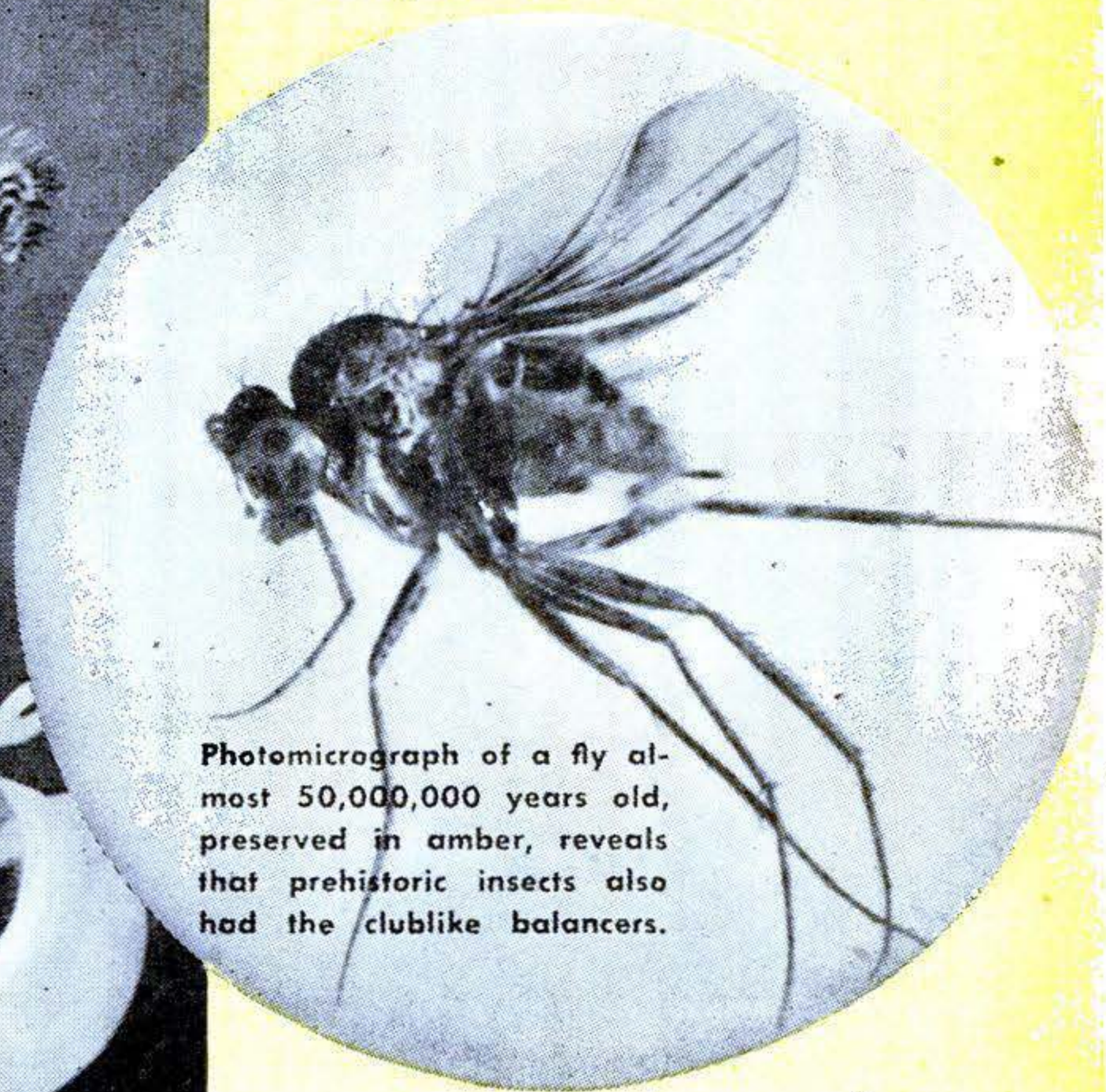
A MECHANIZED, foot-long plastic model of an ordinary fly, built for the Sperry Gyroscope Company and pictured at the left, demonstrates that nature has provided this household pest with gyroscopic organs that stabilize its flight exactly as an airplane's attitude gyro tells the pilot when he is right side up. Flies, mosquitoes, and other two-winged insects have a pair of these clublike organs, called halteres. Each halter vibrates more than 200 times a second and serves the same purpose as the spinning wheels of a man-made gyroscope.

Entomologists had concluded that the halteres serve the fly as a balancing pole serves a ropewalker, but it took modern ultra-high-speed photography to prove it. Dr. C. H. Curran, associate curator of insects and spiders at the American Museum of Natural History, shot 3,000 frames of motion pictures per second to demonstrate that the halteres vibrate and that they do so in synchrony. He has recently completed a photographic study of various *diptera* (two-winged insects) in flight.

At the bases of the halteres are bundles of nerves, and when one or both of the organs are removed the fly is no longer able to control itself on the wing, but goes in circles, tumbles and lands on the floor immediately, often upside down.



This giant model (left and below) clearly shows the fly's left halter, built to scale, behind the base of the left wing. Made for Sperry Gyroscope Company by Chris Olsen of the American Museum of Natural History, the model is mechanically equipped to vibrate the "gyros" just as the fly does in flight.



Photomicrograph of a fly almost 50,000,000 years old, preserved in amber, reveals that prehistoric insects also had the clublike balancers.

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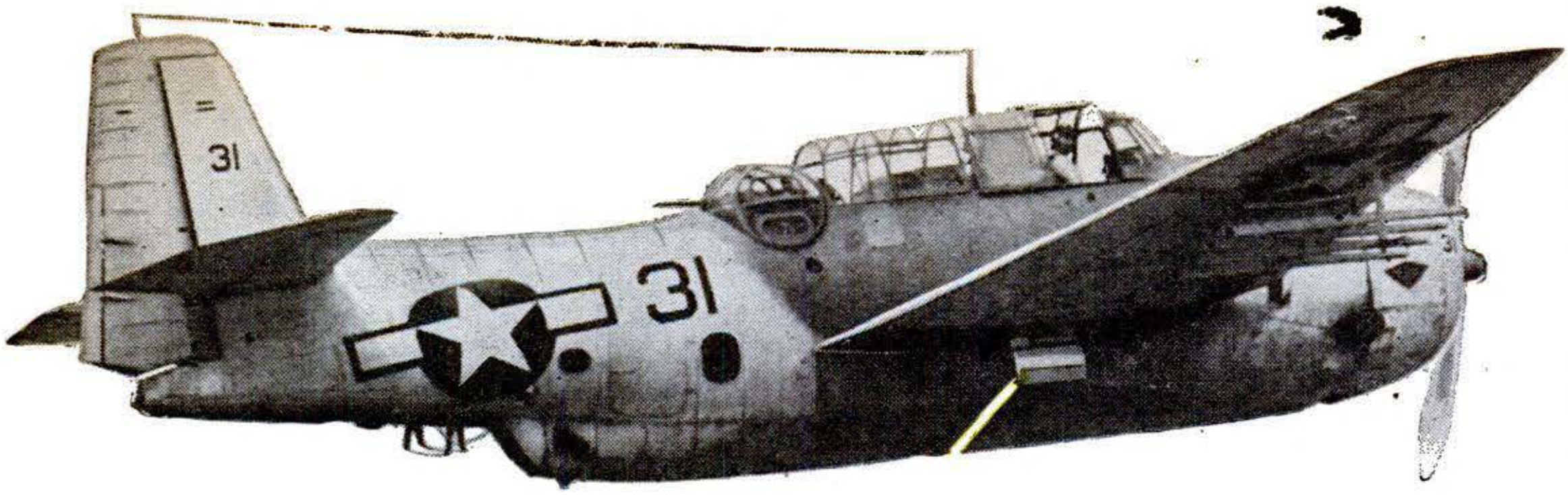


Underground Exploring by AIR

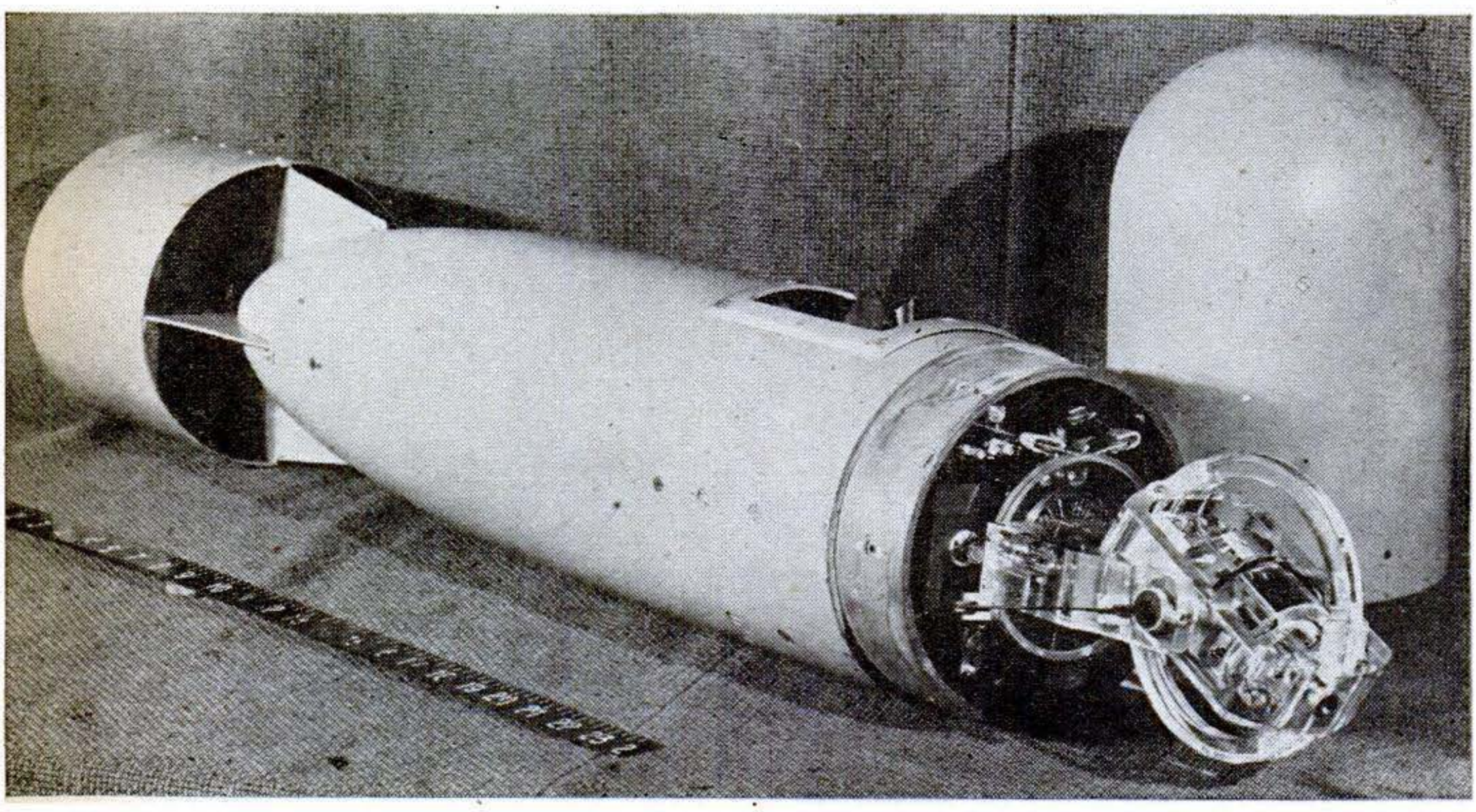
Plane-riding electronic team of MAD and Shoran spots oil, ore.

MORE of the earth's hidden riches will soon be discovered with the aid of two electronic "finders" that formerly put the finger on the enemy's weathered-in bomb targets and submerged U-boats. One is a robot sleuth with an angry name, MAD (Magnetic Airborne Detection), which rides in the sky yet ferrets out magnetic clues deep in the earth that tip off geologists to the presence of oil and mineral deposits. Its air-traveling companion is a precision radar called SHORAN (SHOrt RAnge Navigation) —one of the most significant geographical instruments since the advent of the compass. Teaming MAD and Shoran is the ideal way to locate and stake out offshore tidal oil sites and mineral and petroleum sources in the tropical jungles, frigid arc-

By JAMES L. H. PECK

Drawings by ERIC SLOANE

The supersensitive magnetic head of MAD's 40-inch "bird," which responds to sources of magnetism buried in the earth, is here uncovered. Tail fins give this device flying stability and lift as it dangles 40-50 feet below plane. Tow cable has inner core connected to electronic unit in the plane.



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tic, mountainous areas, or any other regions.

MAD is essentially a flying "magnetometer" that measures with incredible sensitivity any local variations in the earth's magnetic field: the kinds of variations caused by certain types of geological formations. Its first peacetime job was charting Naval Petroleum Reserve, Area 4, in and off Alaska.

Shoran locates an airplane in space so accurately that the technique is being used by the U. S. Coast and Geodetic Survey as an electronic yardstick to measure distances on the earth's surface. The spot-marking radar—that seems destined to replace the surveyor's theodolite, the map makers' tools, and even the navigator's sextant—pinpoints any location on the globe within a few feet, and measures these Great Circle distances without any contact with earth. The first Shoran-MAD combined operation—supported by aerial cameras—was a reconnaissance mission over Iron County, Michigan, and the Adirondack Mountains in a search for iron ore deposits for war use.

Tests reveal that MAD provides a more accurate appraisal of what's below than slow-moving ground parties obtain with conventional methods of magnetic exploration. And Shoran accurately charts such findings simply by transmitting radar pulses from the airplane to a couple of ground Shoran stations, which immediately shoot the pulses back to the plane along the same path. The round-trip time of the radio pulses is measured in "microseconds" and translated automatically into readings of miles and feet. Distance indications from two ground stations, whose location is previously known to the navigator, fix the plane's position so accurately that a plane-to-ground line 250 miles long can be measured to within plus or minus 10 feet.

Prospectors' planes can operate over any territory, in any direction from Shoran ground stations, so long as they remain within range of the installations. Their navigators can determine distance by beaming, or interrogating, any one station, but must transmit signals to two stations to obtain a definite fix.

Mechanism of MAD

The business end of MAD is a bomblike "bird" (see page 128), which rides at the end of a tow cable below the prospecting plane. Because of the lifting qualities of its design, the bird does not exert its full 40-pound weight on the cable when it is airborne.

The bird's magnet head has no other function than that of responding to sources of magnetism buried in the earth. This data is then passed on to the four MAD units inside the plane: an electronic unit, a control box, a power unit, and the magnetograph recorder, which supplies the real magnetic information.

A pen device traces out the message from beneath the earth on a roll of graph paper. The pen's wavy line reveals the amount of magnetic change, or "anomaly," that takes place in the area over which the plane is flying. The amount of variation is read off a scale calibrated in gamma units. MAD recording is automatic and requires little attention from the operator, who may be the plane's navigator.

When several test MAD sets were being built during the war at the Bell Telephone Laboratories, technicians found it necessary for all workers to be "magnetically sanitary." Some worked without shoes, watches, knives, belts, and certain clothing, so that no metal would affect the delicate mechanism. Even dirty fingernails influenced certain parts of the equipment.

A new employee practically disrupted assembly at one time by neglecting to mention that a small bit of a needle, which had broken off in her finger some years before, had never been removed. For certain experiments even "sanitary" locations had to be found that were magnetically stable: one was at Quonset Point, R. I.; another at Cold Spring Harbor, L. I. When the device finally went into production, almost surgical precautions were observed.

Efficient as it is, MAD has a lack of depth perception. It locates mineral lodes with reasonable accuracy, but does not indicate the size or depth of the deposit. A small vein of ore near the surface is likely to give the same reading as a larger lode deeper in the earth. When the ground parties go to investigate the aerial findings, they must use seismic sounding with buried dynamite charges, or other methods, to ascertain the depth of the veins.

One of the prospector's problems has always been that of staking his claim with accuracy. The precision of Shoran navigation enables modern surveyors to chart an area in a few minutes that would require months of work by conventional methods.

"Already Shoran has broken down previ-

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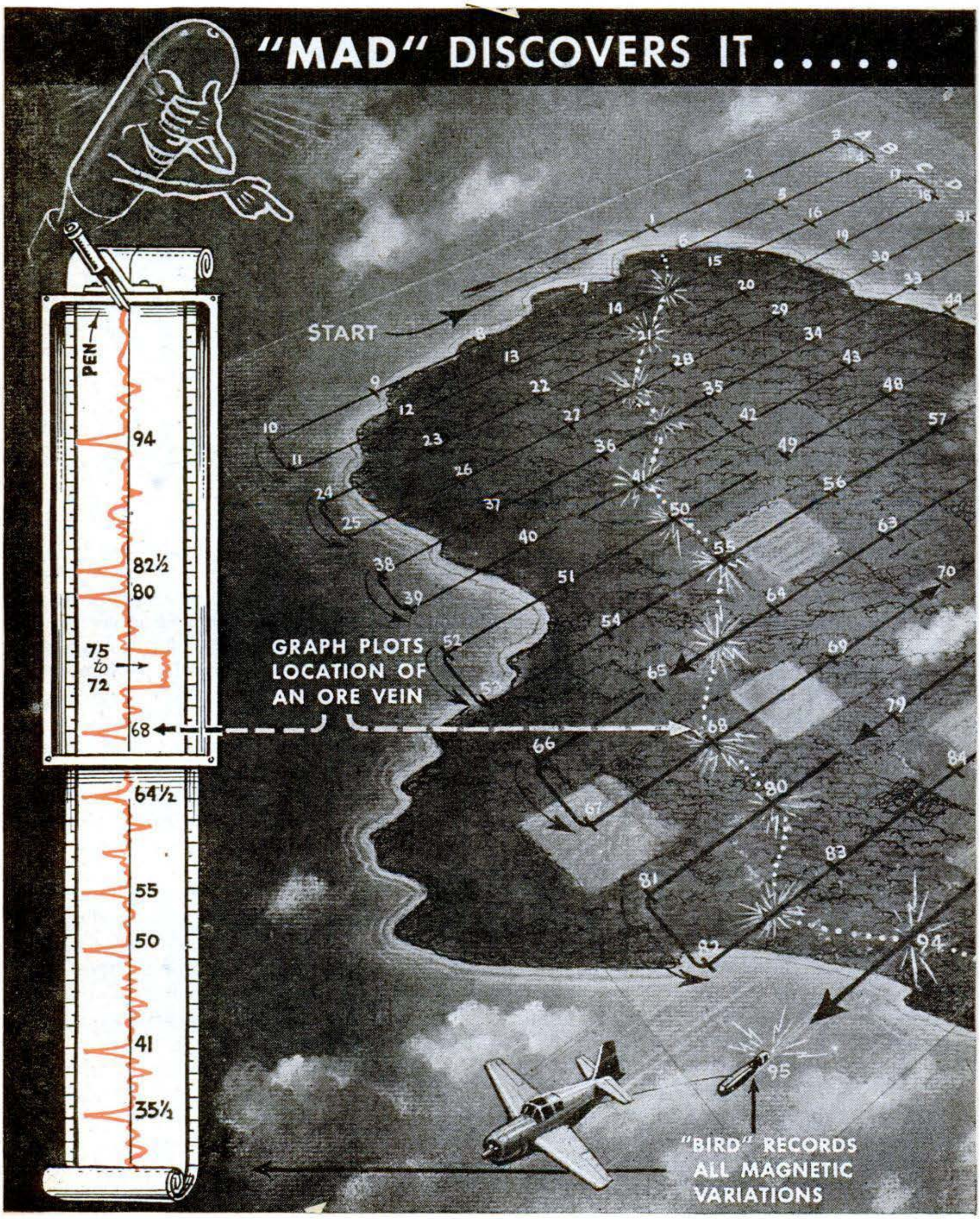
ous means of calculation, and indicated that places on earth are not where they appear to be on the map," said one scientist who helped develop a Shoran attachment for mapping. "It will now be possible (with a network of Shoran stations in different parts of the world) to plot any point from any other point within a few feet. For the first time, huge unmapped areas can be pinpointed and added to existing charts, with obvious benefit to aerial and sea navigation."

How Shoran Works

In principle, Shoran combines the bouncing-echo feature of ordinary radar with the pulse-timing technique of LORAN (LOng



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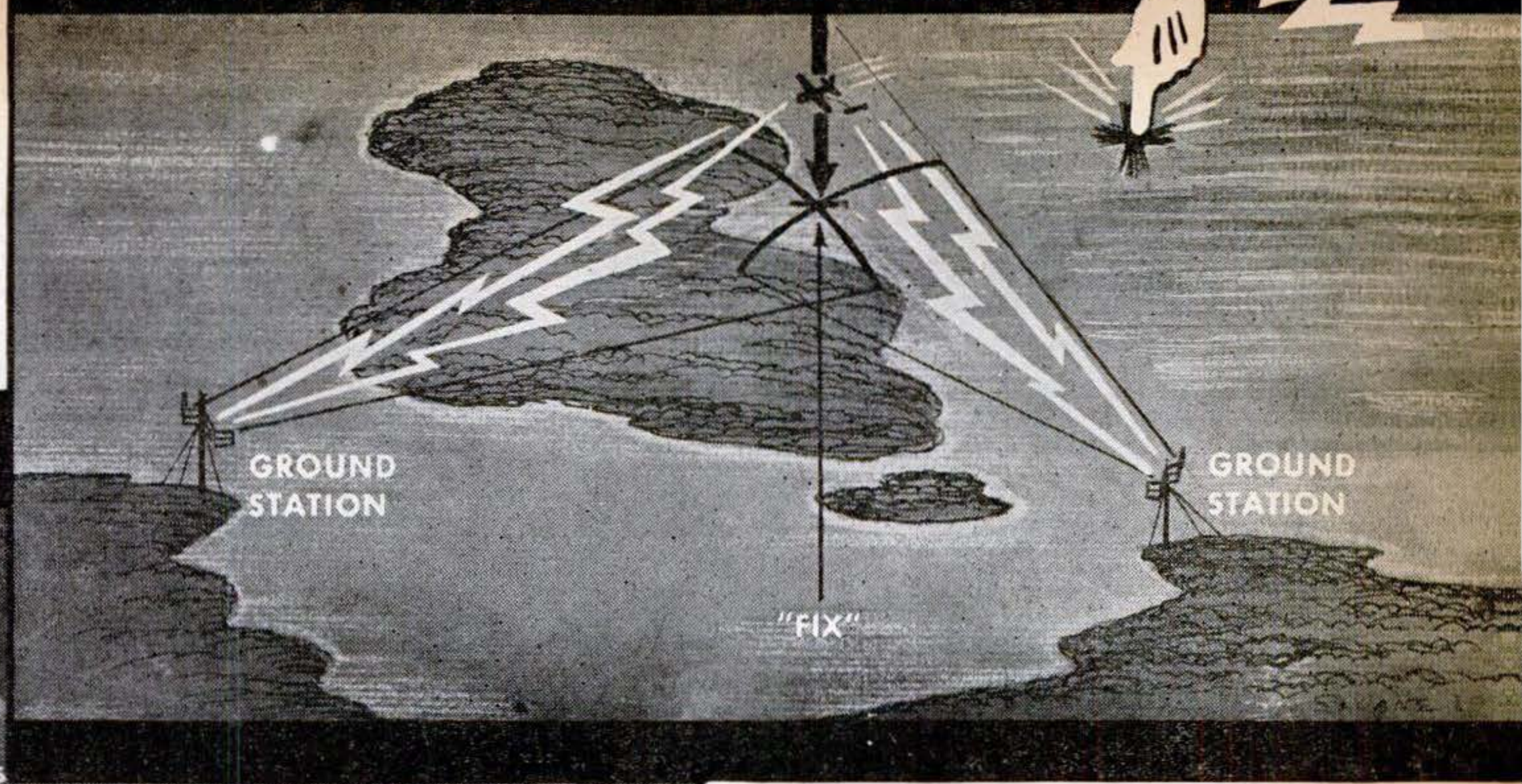
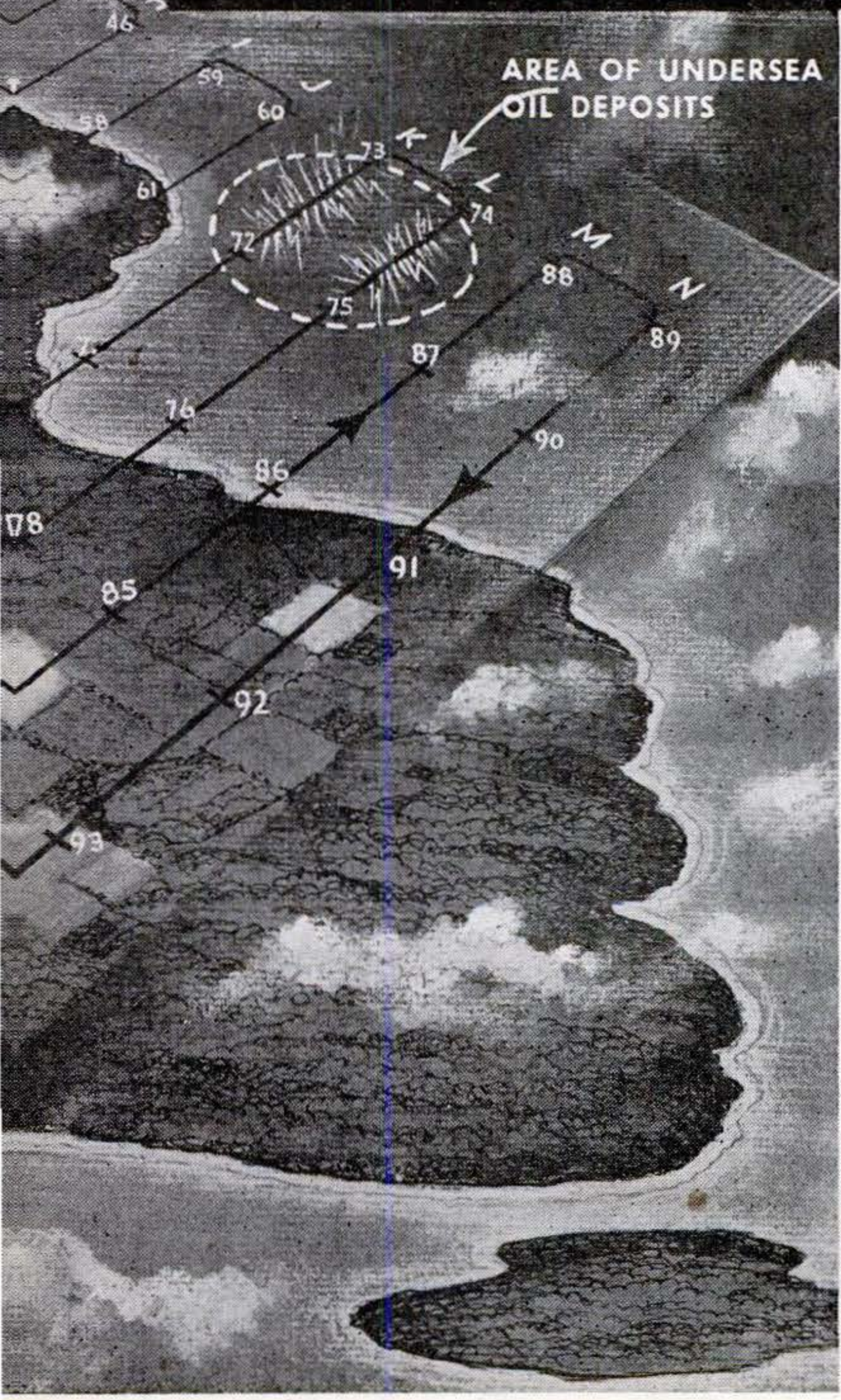
. . . . . "SHORAN" CHARTS IT





Survey plane carrying MAD and Shoran units flies back and forth along the lines of a grid of one-mile co-ordinates superimposed on a chart or aerial photo. Its navigator can obtain Shoran fixes to show exactly where the plane is when the peaks and dips of MAD's recorder reveal magnetic variations in the earth.

RAnge Navigation. PSM, Feb. '46, p. 78) and radar beacons. Conventional radars transmit beams that strike some object and are reflected back to the receiver. Shoran uses the ground station to catch and *amplify* the returning radio pulses. The extra kick is given to the echoes by a type of transpondor in the ground set that is similar to the IFF transpondor used to identify friend from foe during wartime (PSM, Sept. '45, p. 65). The interrogating pulses from the airborne Shoran set are received and routed to the ground transmitter unit. Here, the pulses spring an automatic triggering circuit, which instantly retransmits them to the interrogating plane.

It is far easier for the Shoran operator to interpret the dome-shaped light "pips" on his scope (see page 132) than it is with other types of radar, and his readings are far more accurate. The Shoran dial indicates directly to the nearest 1/200 of a mile (26 feet), and can very easily be figured to the nearest 1/500-mile (10 feet). When a bombing or mapping computer is attached to the air-

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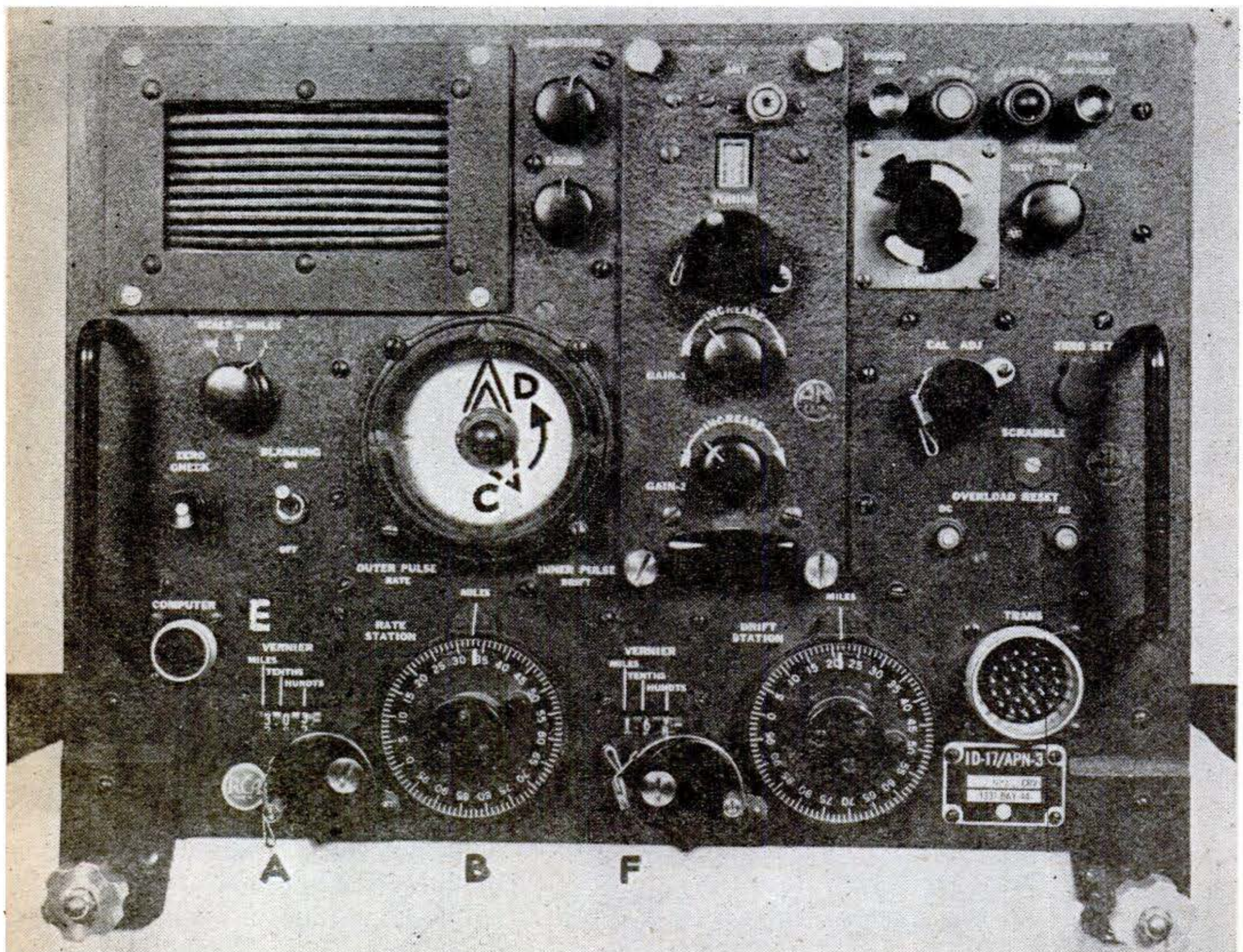
borne set, the operator makes about three prior settings and the pips are kept aligned automatically.

When the operator desires a "fix," he must align three pips instead of two. The transmitter interrogates first one ground station then the other, by sending alternate pulses on frequencies about five to 10 megacycles apart. Separate timing circuits are installed so that both Shoran distances can be read from the two separate mileage indicators at a glance. Like other radar scopes, the Shoran screen has a range switch. The operator can get a 100-, 10-, or one-mile presentation, according to the distances and territory over which the survey plane operates. Such a survey of an island and its tidal waters is shown in the diagram on pages 130-131.

When the plane lands from a survey such as the one diagramed on these pages, its chart is given to geologists for evaluation. These experts know what magnetic "anomalies" a certain type of iron ore, for example, will cause at certain points on the globe. Thus, a definite magnetometer reading indicates indirectly what is below the surface by noting the magnetic departure from normal. The MAD equipment is carefully adjusted before or during flight to conform to the local magnetic declination of the area being surveyed. Even the slightest change in the recorder's wavy line tells the operator and the geologists that something is below the surface at that point that interferes with the normal magnetic field of the earth, either by increasing or decreasing the magnetic intensity.

Experts of the Coast and Geodetic Survey say that the MAD-Shoran electronic team will enable them to chart the first really accurate magnetic map of the earth. Existing charts, which show the lines of magnetic variation at different points on the globe, are now considered only reasonably good estimates.

Airborne Shoran operator finds how far he is from a ground station by turning crank A until "pip"(C), which is its returning pulse, is aligned with the transmitter pulse (D). He then can read the approximate mileage on dial (B), but for an exact reading in tenths and hundredths he glances at vernier scale (E). Operator in addition uses crank (F) and its adjacent dial and vernier when he is obtaining a fix.



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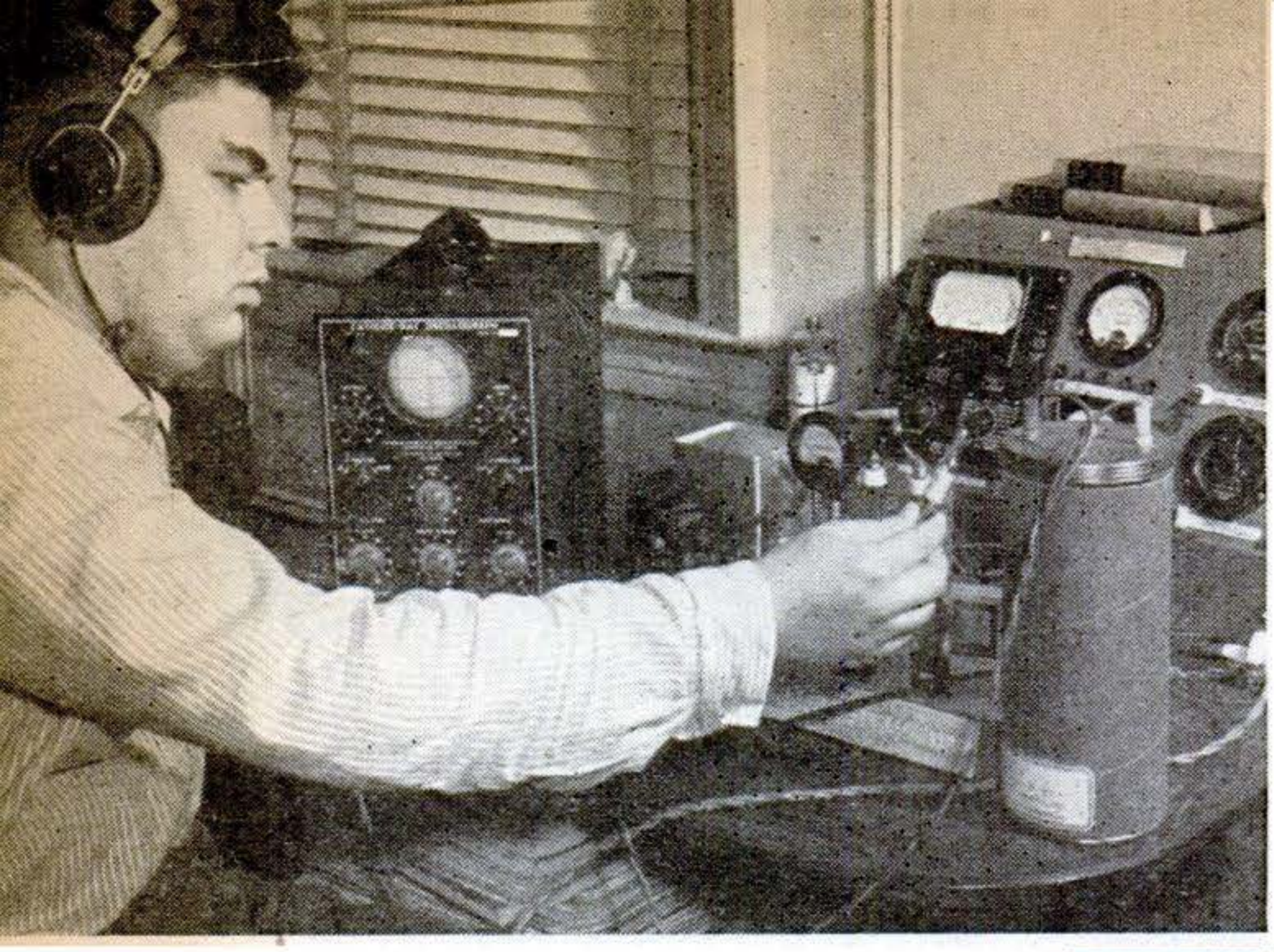
Inside Story of the Wac Corporal

1. ACID TANK
2. ANILINE TANK
3. AIR TANK
4. INERTIA VALVE
5. HYDRAULIC ACCUMULATOR
6. PROPELLANT VALVE
7. ROCKET MOTOR
8. PRESSURE REGULATOR
9. TANK PRESSURIZING VALVES
10. AIR CONNECTOR
11. AIR FILLING CHECK VALVE
12. AIR DUMP VALVE
13. ELECTRICAL CONNECTION
14. ANILINE FILL PORT
15. ANILINE VENT PORT
16. ANILINE BLEED VALVE
17. AIR INLET
18. FUEL FILTER
19. ACID FILL PORT
20. ACID VENT PORT
21. GYROSCOPE
22. GYRO BATTERY
23. BLOWOUT PLUG
24. NOSE CONE
25. MISSILE PARACHUTE
26. RADIOSONDE
27. RADIOSONDE PARACHUTE
28. BOOSTER THRUST SOCKETS
29. FAIRING TO ENCLOSE PIPING
30. LEAD BALLAST TO ADJUST CENTER OF GRAVITY

WHAT hurled the needle-pointed rocket, Wac Corporal, 50 miles straight up from its lofty launching tower in New Mexico has now been revealed by scientists of the California Institute of Technology. They built the half-ton, 16-foot projectile and concocted the propellant that sent it roaring into the ionosphere in a few seconds, powered by an aniline-burning motor and using nitric acid as an oxidizer. The cutaway sketch at left reveals the essential apparatus that made its flaming flight possible. When PSM artist Stewart Rouse drew his shrewd conception of it (May '46, pp. 68-69), the details were still secret.

The Corporal zooms into the ionosphere from this 100-foot launching tower in the New Mexico desert. Below, at right, is the control room and, beyond it, an observation tower.



"HAM" into Scientist

Brooklyn boy shifts from radio to build electronic apparatus.

In his instrument-filled bedroom, Fishman shows how his homemade Geiger-Muller counter (right) registers nuclear particles. Rays from radium solution in tube show on oscilloscope at left.

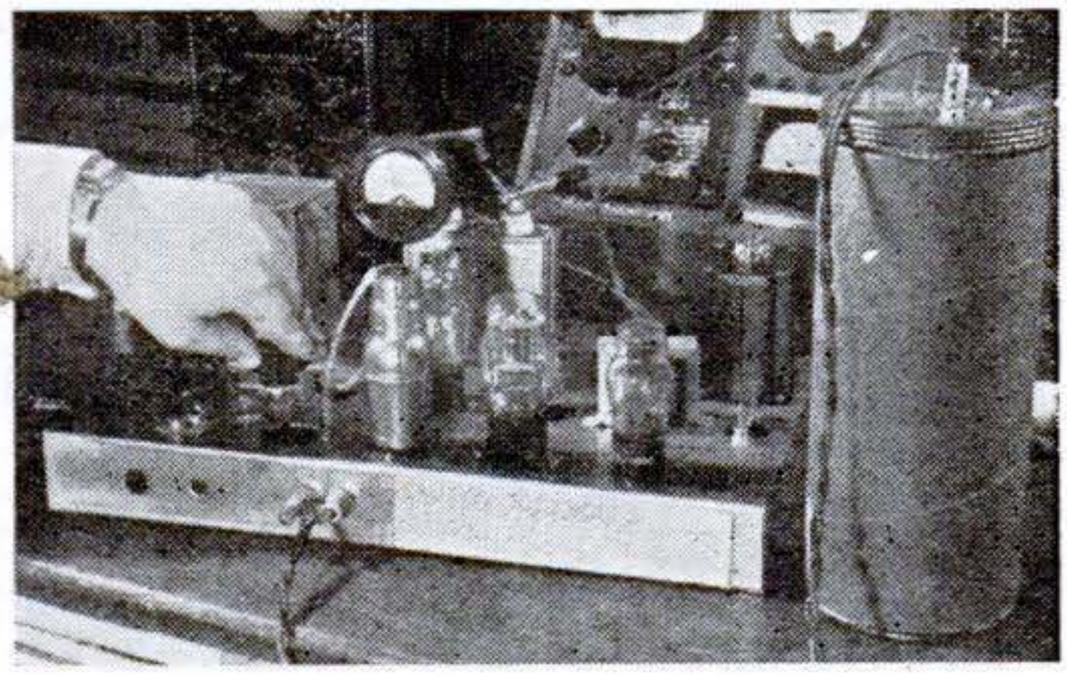
By MARTIN MANN

Photographs by JAMES BRAY

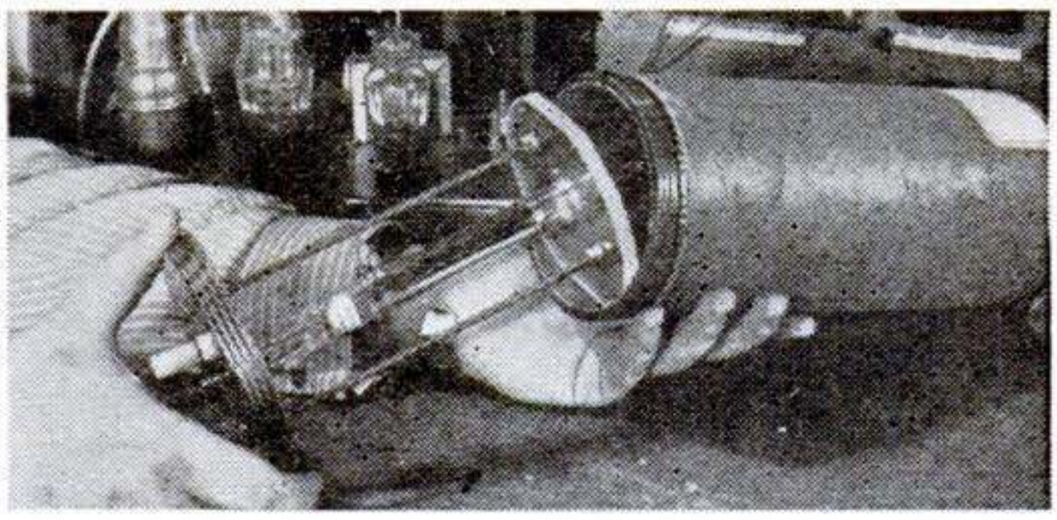
THEODORE Fishman, a New York high school student, will not be old enough to vote for four years, but his passion for science and exceptional mechanical ingenuity have enabled him to build X-ray machines, Geiger-Muller counters, and other advanced electronic apparatus in his bedroom laboratory.

An enthusiastic ham radio operator in his younger days, the 17-year-old Brooklyn boy became interested in making radio crystals control frequency more precisely by exposing them to X-radiation. This led him to build an X-ray machine of secondhand parts and developed the need for a device to measure the intensity of the X-rays. Learning of a new ether-filled detector tube that would make a Geiger-Muller counter sensitive to X-rays (commonly used counters are not), he had the glass tube blown by a local instrument maker, filled it himself, and assembled the counter around it. Since then he has made two other counters, one of them on order for a Brooklyn hospital at a cost less than one-fourth the price of similar commercially built instruments.

Fishman now plans an all-purpose laboratory oscilloscope with a five-inch screen, sweep-circuit frequency range of 0.2 to 100,000 cycles, and amplification frequency range from zero to 5,000,000 cycles. He expects to build it for about $20.

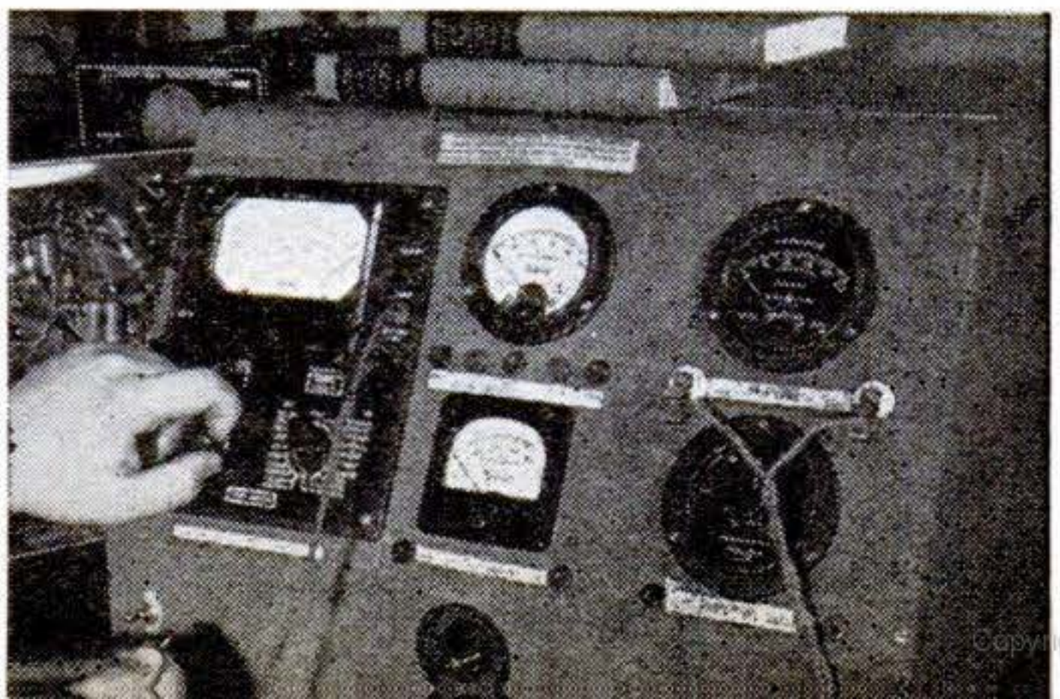


With 3,000 volts building up across the condenser in the rear, he is careful in adjusting his counter. A new-type detector tube is the principal variation from the standard circuit.



Fishman's ether-filled detector tube will not break down under X-radiation, as do the argon-alcohol tubes in most Geiger-Muller counters, and therefore he can use it to measure X-ray intensities.

A student at New York's Stuyvesant High School, Fishman has designed a special test panel to check the circuits in his counter. He hopes to become an electrical engineer.



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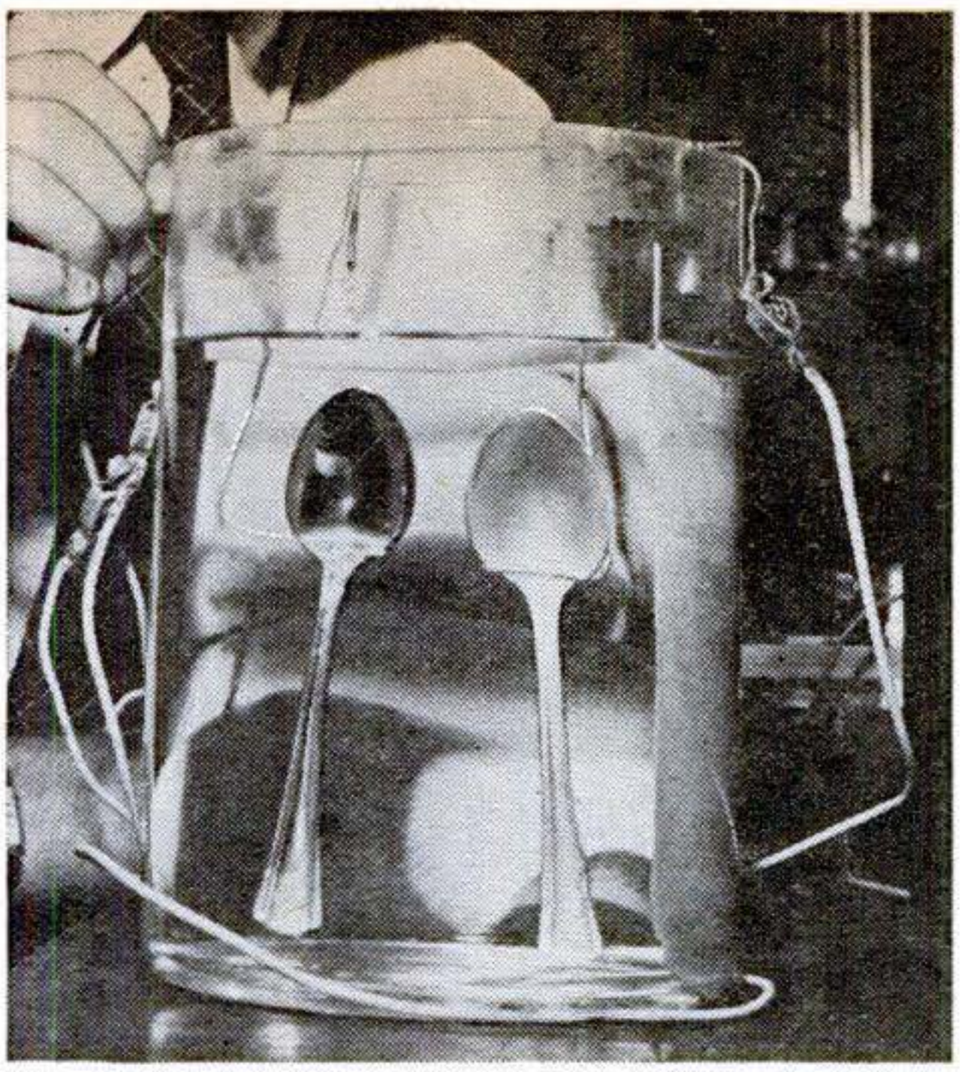
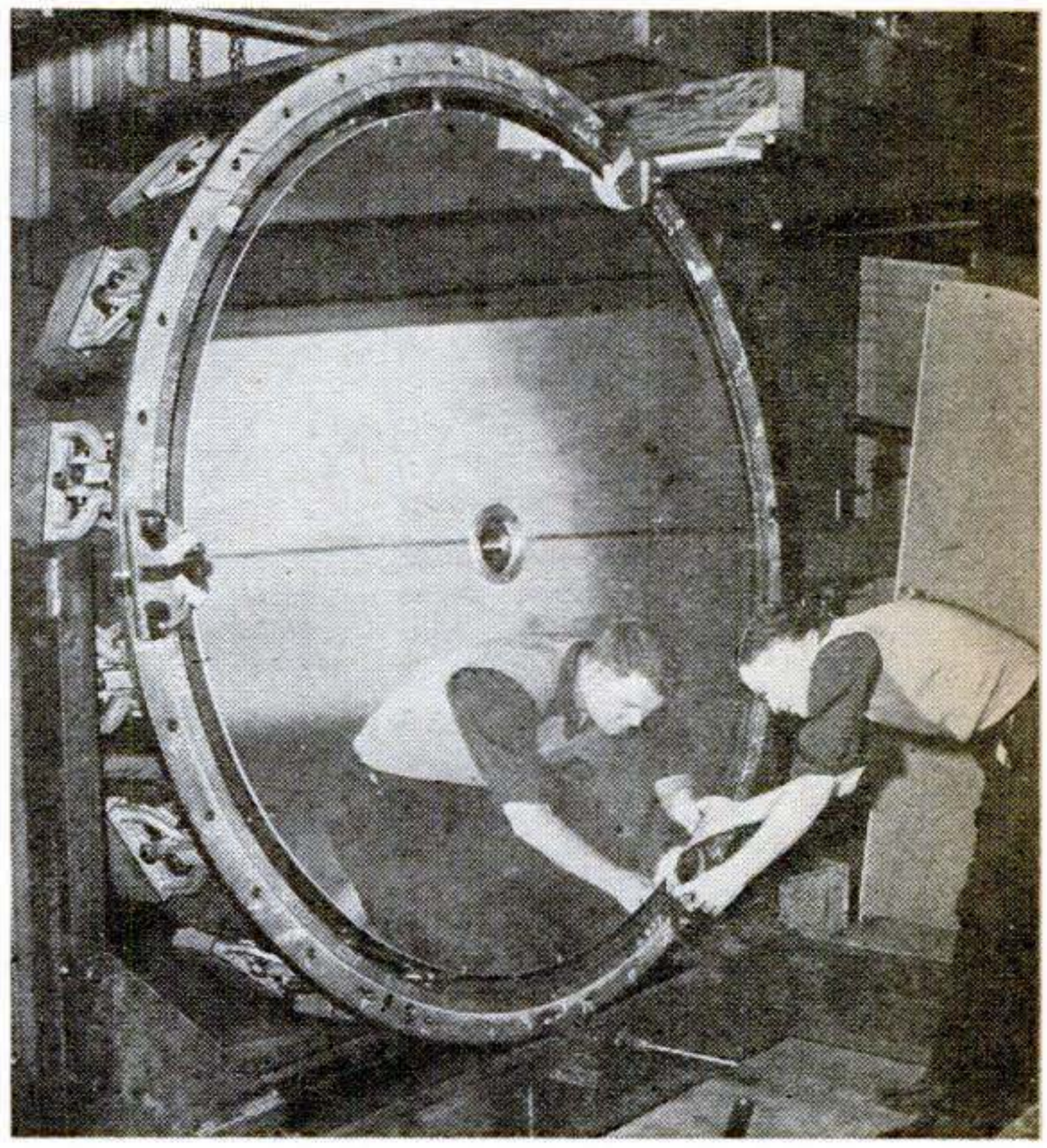


Biggest Camera Mirror. Technician Don Hendrix, of the Mt. Wilson Observatory, Pasadena, Calif., is shown below making final adjustments on the world's largest camera mirror. When finished, the giant reflector will be used with a 48-inch, F/2.5 lens in a Schmidt camera telescope to photograph the heavens from Mt. Palomar Observatory.



60-Second Shiner. Without a buffing wheel or cloth touching it, the spoon at right, above, will take on a glittering luster like the one at the left in little more than a minute when a positive current is shot intermittently through the silver cyanide coating solution in which it rests. Discovered accidentally by Dennis Turner, Westinghouse physicist, the new process may outmode standard buffing methods.

Antijolt Engine Seat. Jolting and jarring, which make switch-engine operations a tough task, are eliminated for the engineer who rides the seat (left) made by Monroe Auto Equipment Co. The shock absorber controls the spring action, while the sway bar reduces side sway.

Army Knife Is Rustproof. With high-carbon, cutlery-steel blades and a stainless-steel handle, the pocketknife below defies rust and corrosion. Developed by Army Quartermaster Corps, it is ideal for sportsmen as well as soldiers.

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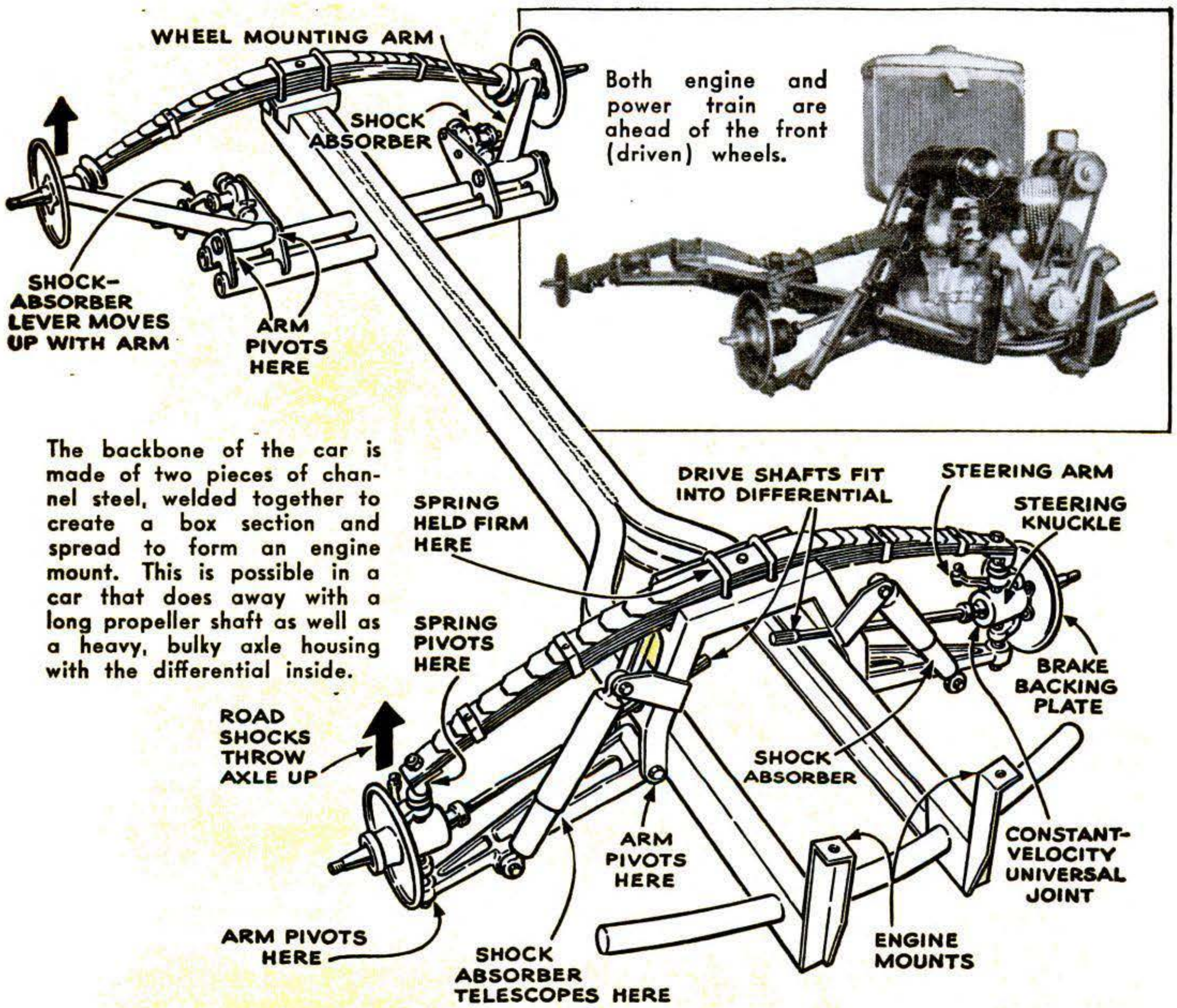
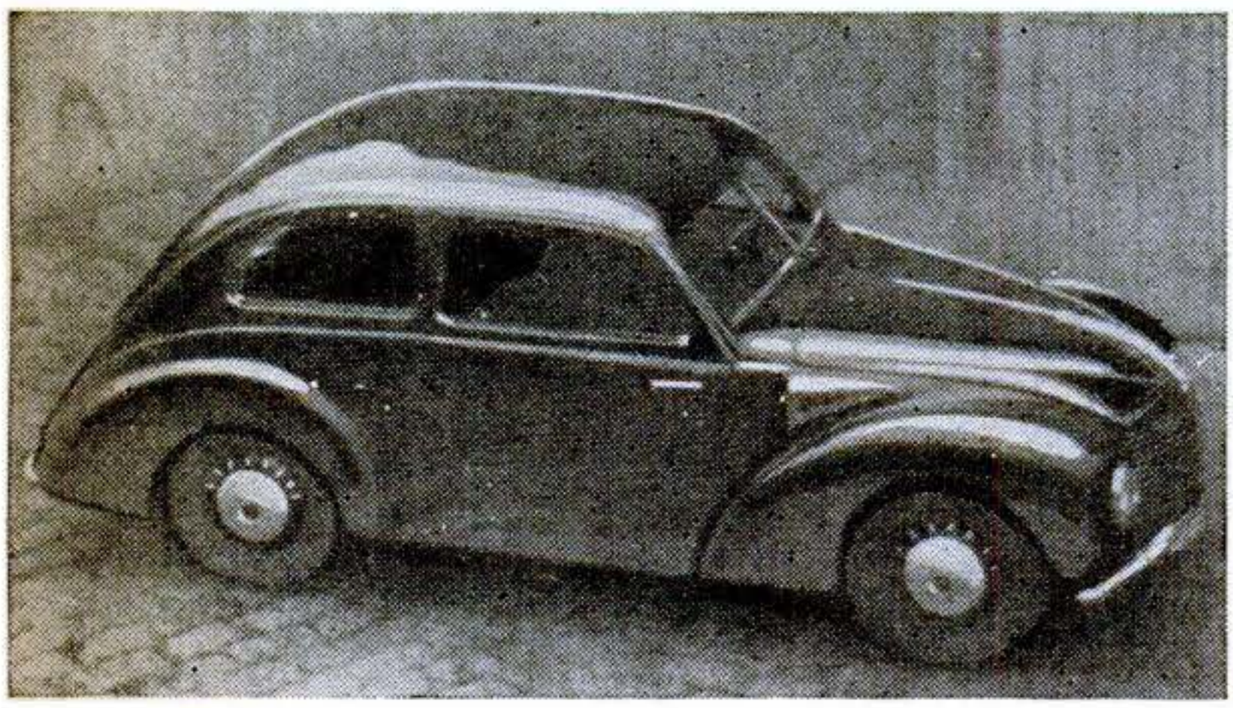
New Czech Car Is Built



The backbone of the car is made of two pieces of channel steel, welded together to create a box section and spread to form an engine mount. This is possible in a car that does away with a long propeller shaft as well as a heavy, bulky axle housing with the differential inside.

SECRETLY designed and tested during the German occupation, this clean-cut new Czech car is an excellent example of European light-car engineering. Its principal features include the backbone frame, a two-cycle twin-cylinder engine, and front-wheel drive. As in most cars tailored to suit European tastes and driving conditions, it is built for extreme operating economy (better than 40 miles per gal. at cruising speeds) and for good riding on poor roads.



The car, which is called the Jawa-Minor and is manufactured in Prague, weighs only 1,507 lb.—about half the weight of popular light American cars. Its little engine, rated at 20 brake hp., delivers a top speed of just over 60 m.p.h. with a comfortable cruising speed of around 50. The clutch, transmission, and differential are housed in a single unit directly behind the engine, a compact arrangement that adds to the usable passenger-compartment space. The wheel base is 90.6″.

To take the rough and badly maintained roads of central Europe, cars must have sturdy and effective

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Around Steel Backbone

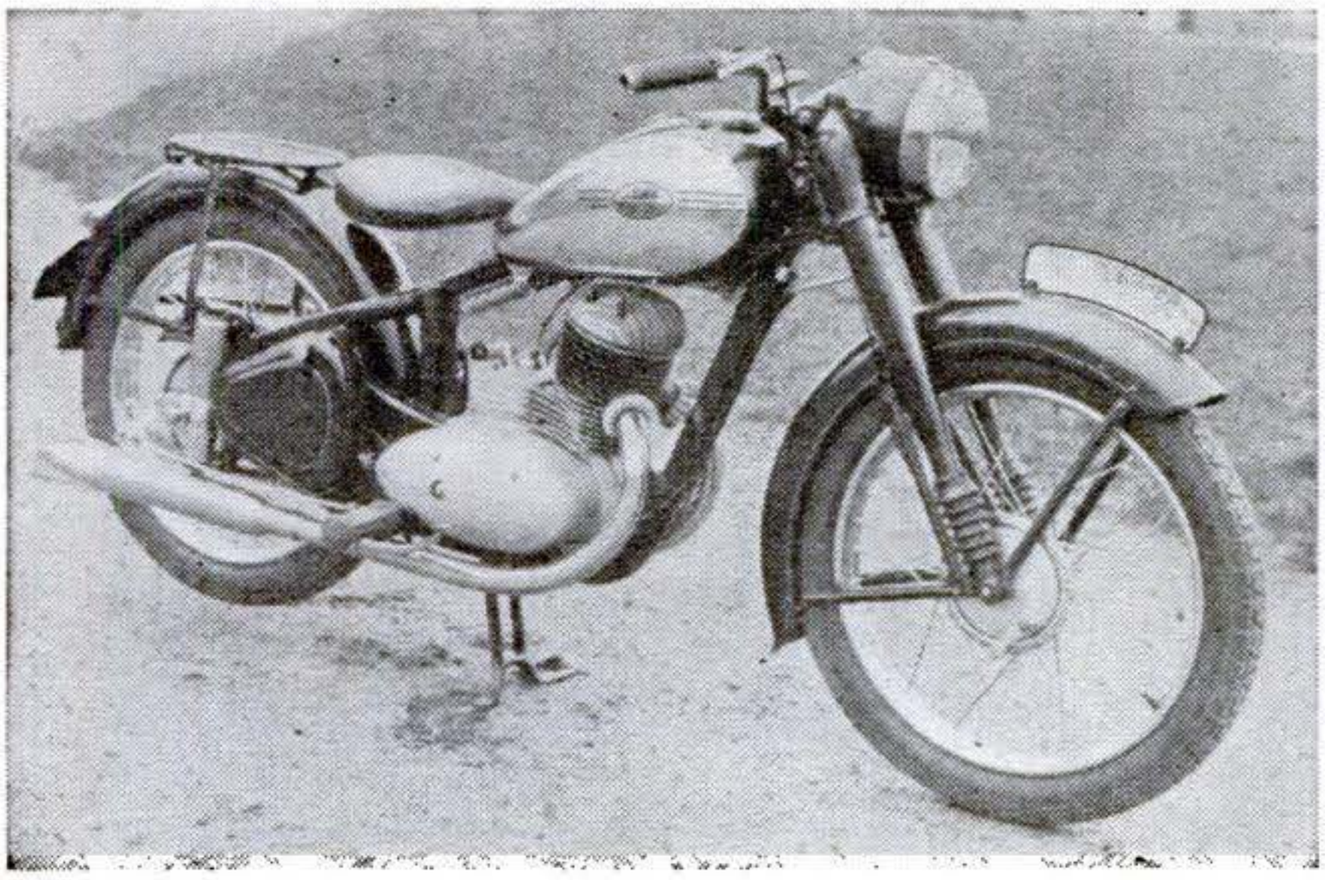
Mechanics will enjoy the easy access for working. The air cleaner is at left in the compartment; at right are the generator and two ignition coils.

The gearshift lever, which is moved in guide slots on the dash, gives a choice of four speeds forward. Third is direct; fourth is a 20-percent overdrive.

springing. Czech engineers tried out half a dozen suspension systems before fixing on the method pictured in the accompanying drawing. According to a U. S. official stationed in Prague who has tested the new car, the Jawa can be driven with ease across a ploughed field at high speed. Relatively little unsprung weight, the absence of conventional axles and axle housings, and careful shock-absorber design are important elements in obtaining this excellent roadability.—Bernard P. Blankman.

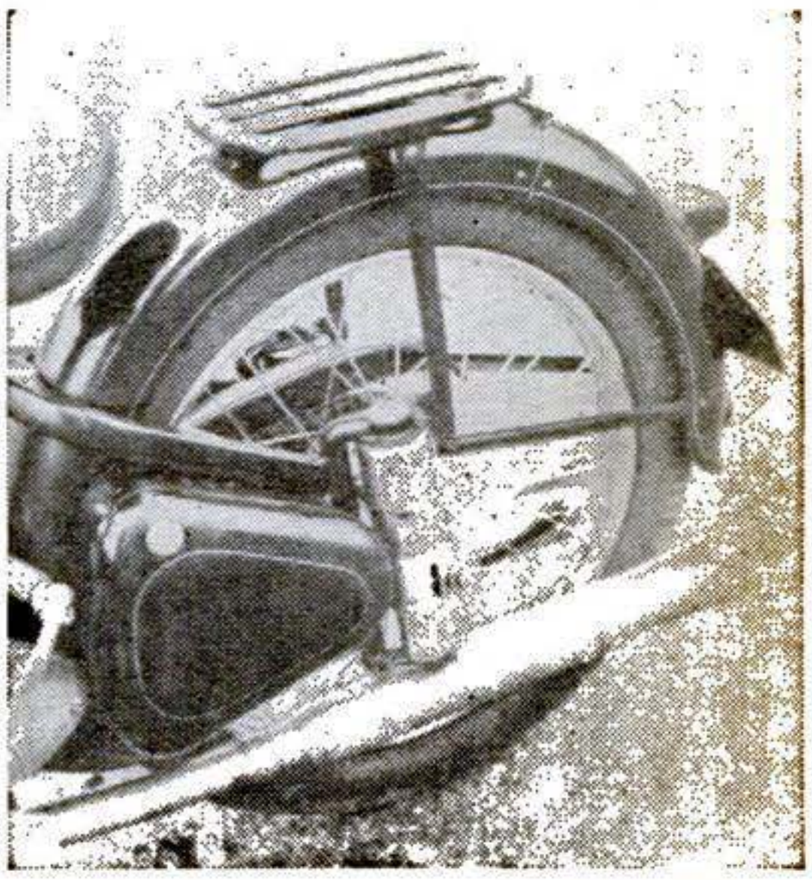
New Single-Cylinder Czech Motorcycle Is Light and Fast

Automotive engineers in occupied Czechoslovakia also secretly built a one-cylinder motorcycle now being produced by the Jawa Company, of Prague. The design shows an emphasis on clean lines. All the wires and cables that climb around most motorcycles are concealed. The carburetor is enclosed in the crankcase housing, and in the same housing are the automatic clutch and the semiautomatic four-speed transmission. Suspension consists of a coil spring and plunger sealed in a metal tube. Performance figures: 94 miles per gal.; 62 m.p.h. top speed; weight, 240 lb.



The fork holds the headlight at top and the coil springs and plunger at bottom. There is a weight adjustment on the seat.

Here is the rear spring. Tools are in the box, a battery in one opposite.



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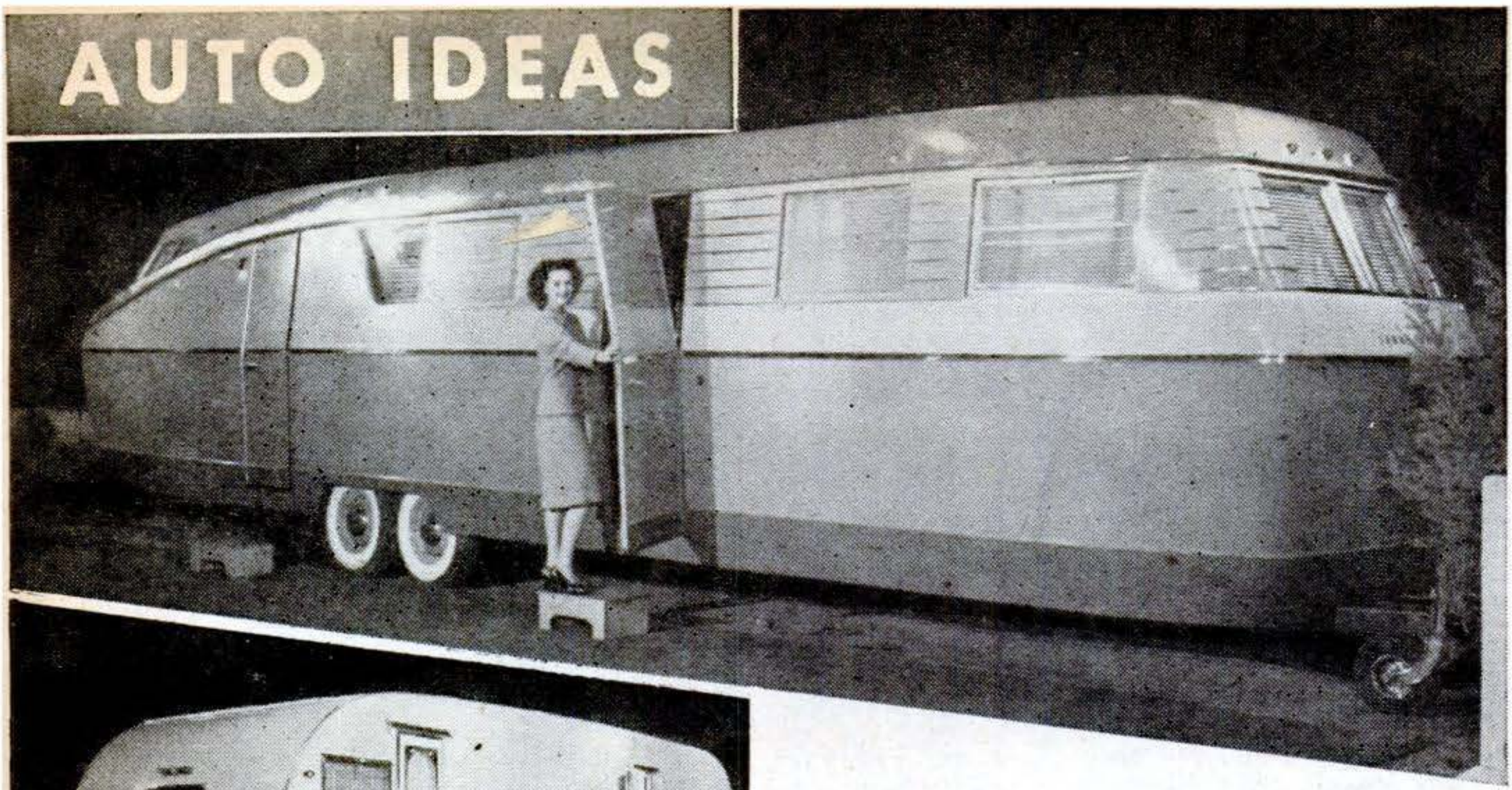
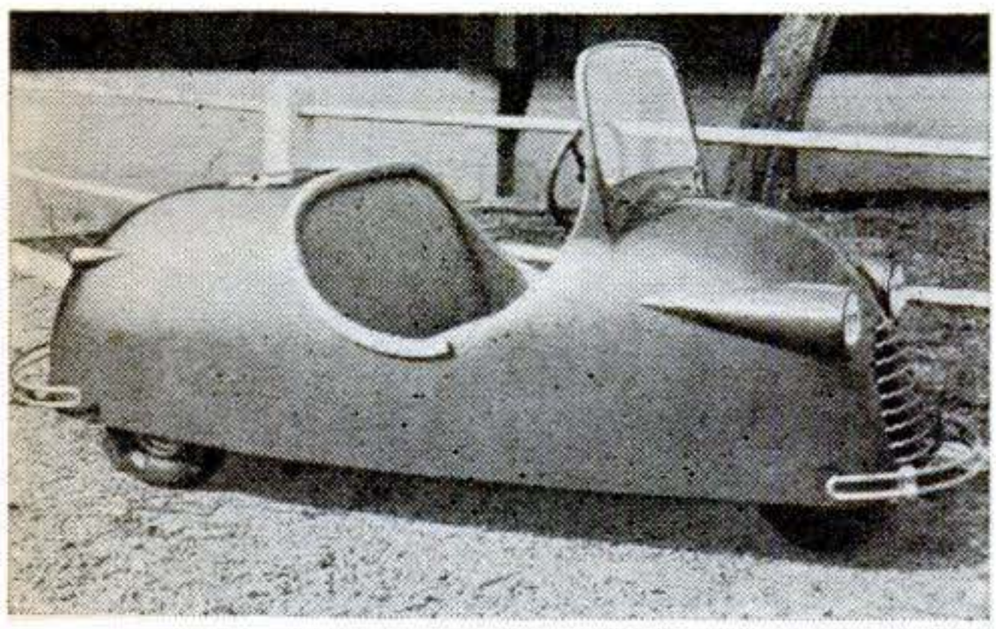
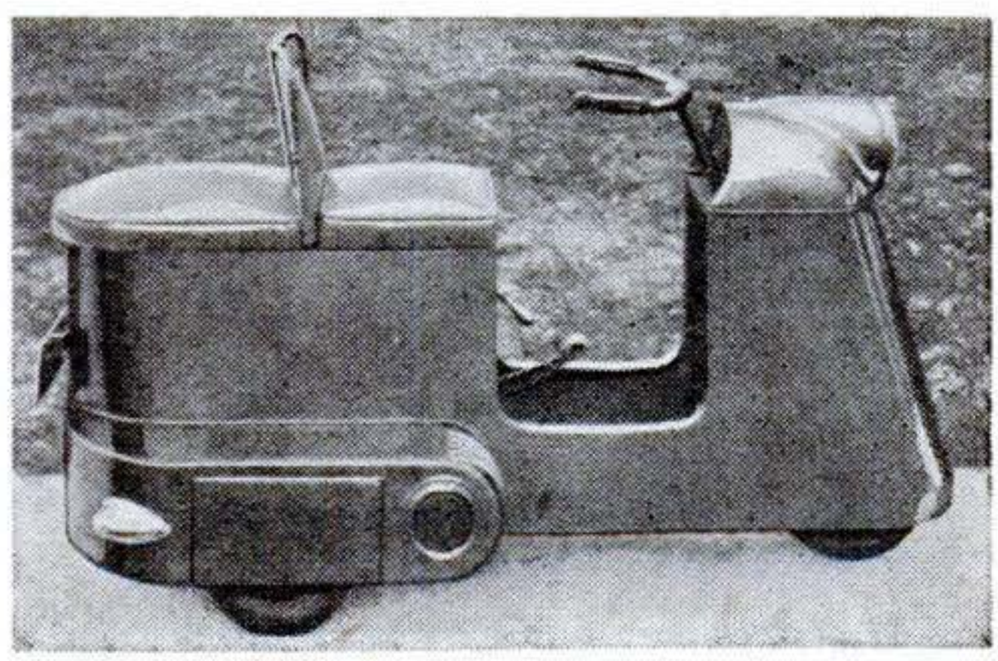
AUTO IDEAS



LONG, LONG TRAILERS. Almost comparable to a four-room house, the trailer at the top is the "Terra Cruiser," a 38′ model with an all-electric kitchen, a bedroom-living room, and a bathroom with a shower. The living room, with sofa and chairs, fireplace, and indirect lighting, is built at the rear and has windows like the observation car of a train. Shown in the smaller photo is a 35′ "Shoreland Tandem," which has four rooms, hot and cold running water, and an air-conditioning unit. The couple pictured are about to enter the living room, while the door at the rear leads to the bedroom. According to the manufacturers of both trailers, they can be towed by standard passenger cars without difficulty.



PINT-SIZED AUTOS are planned or in production by numerous manufacturers in various parts of the country. The two shown here are the automotive hopes of the B & B Specialty Co., of Rossmoyne, Ohio. At top is the "Brogan," a low and light job—less than 4′ high to the top of windshield, and weighing 450 lb. It uses a tricycle wheel arrangement with front-wheel steering. A two-cylinder 10-hp. engine is placed at the rear on a special spring mount. Gasoline consumption is 65 to 70 miles per gal. and the top speed is 45 to 50 m.p.h. "The Broganette," below, fits into the motor-scooter class with its 3-hp. engine and handle-bar steering. Speed and mileage figures for this car: 35 to 40 m.p.h. and 85 miles per gal.



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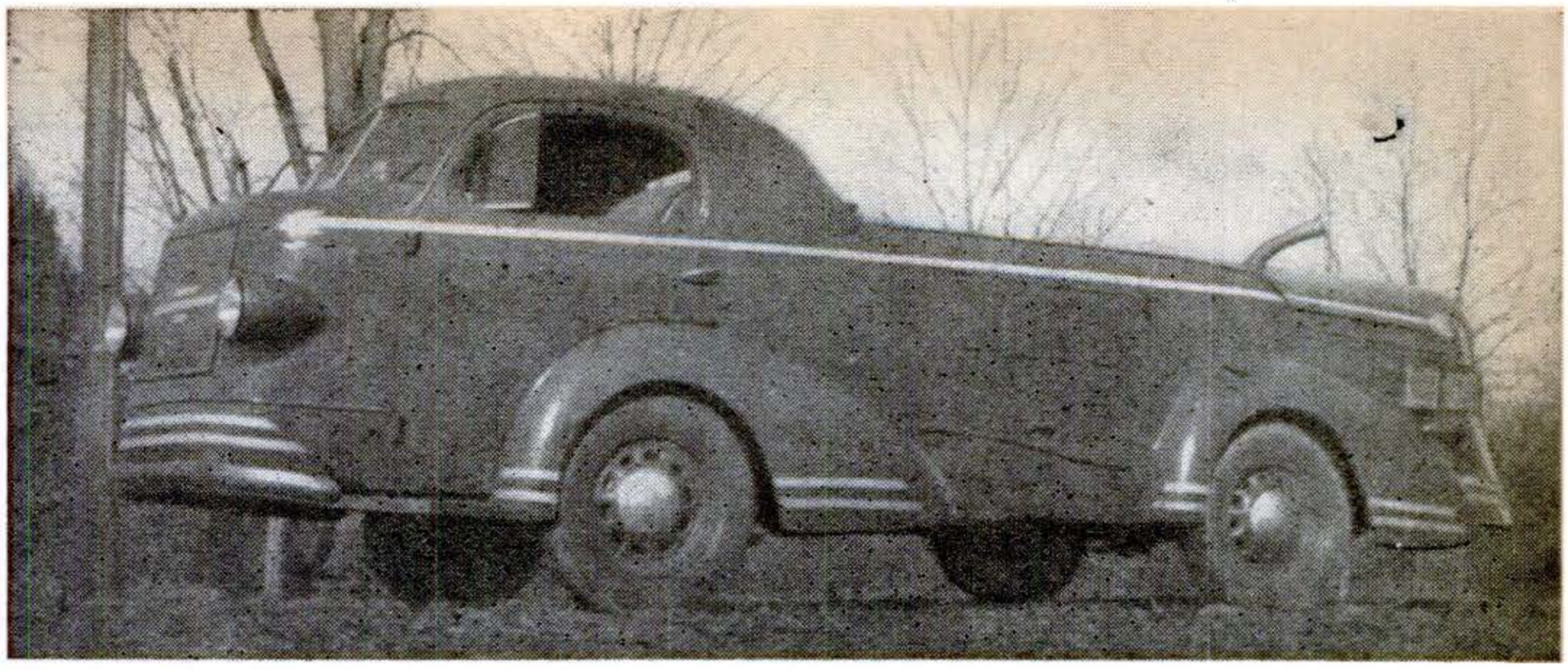
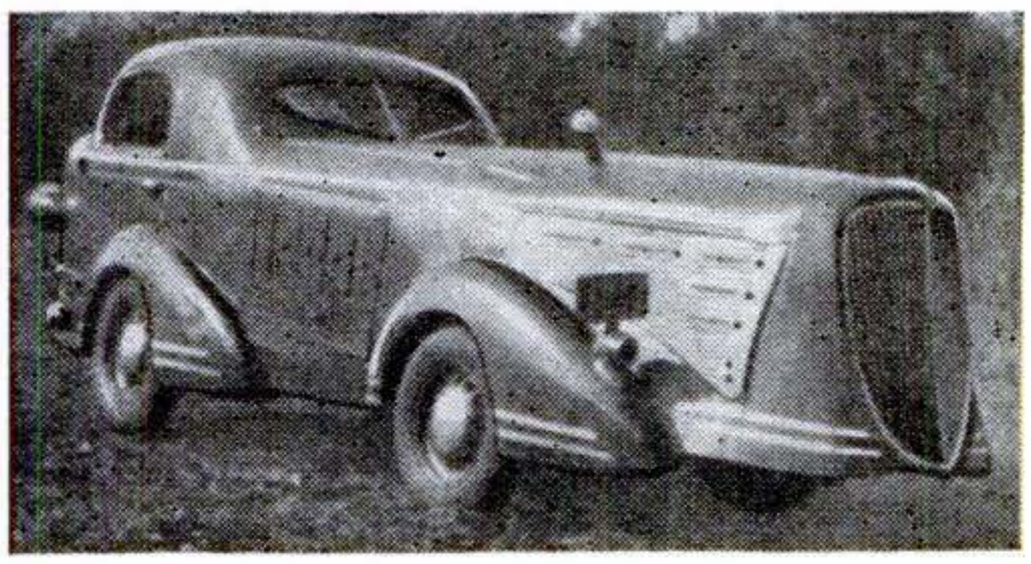
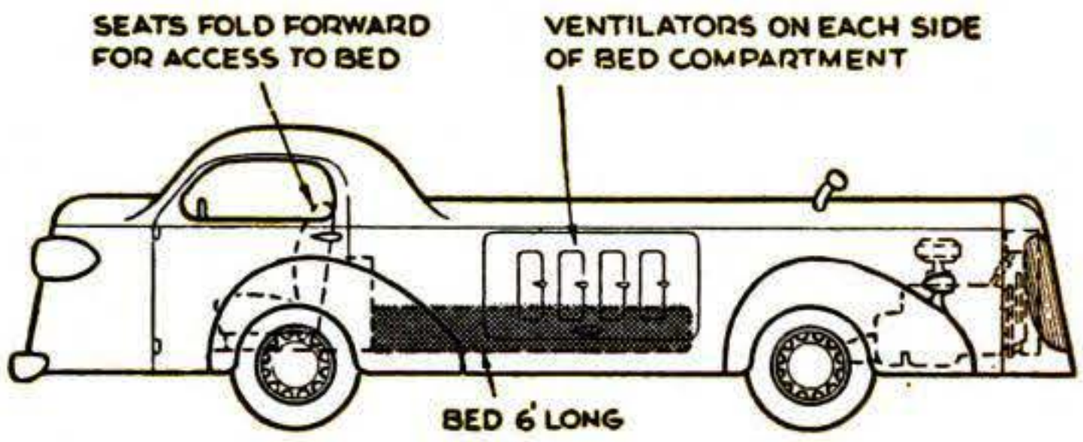
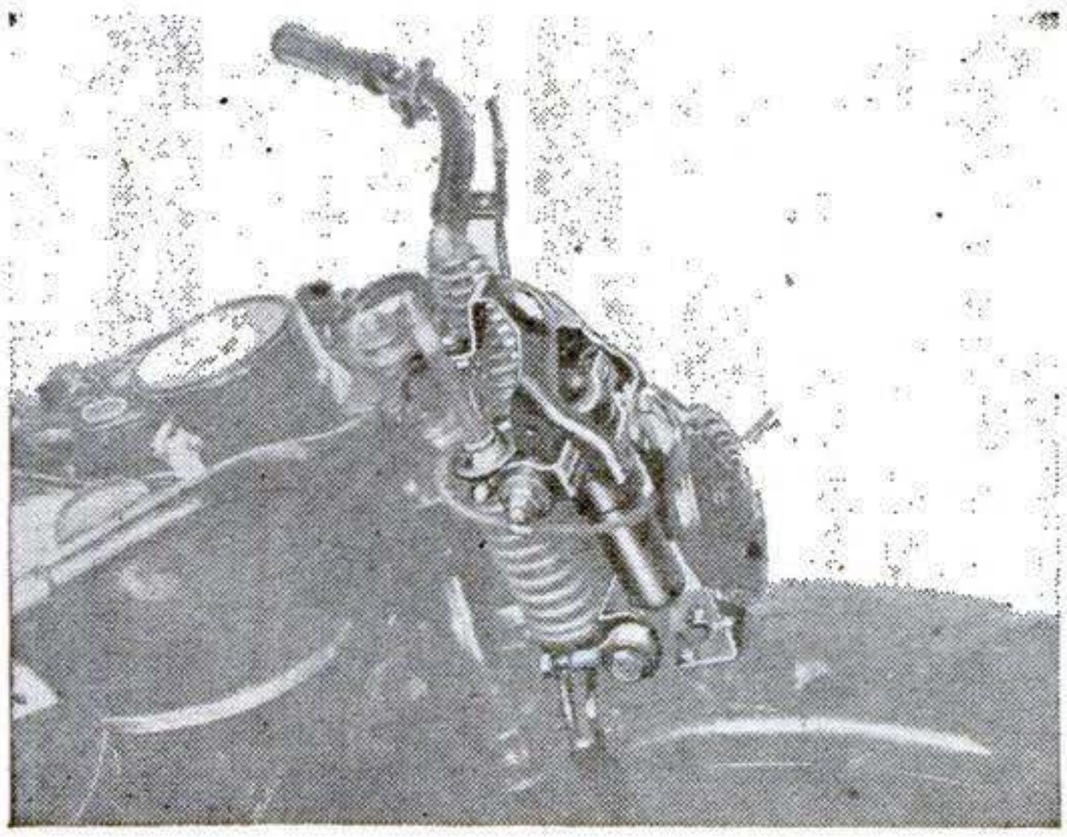


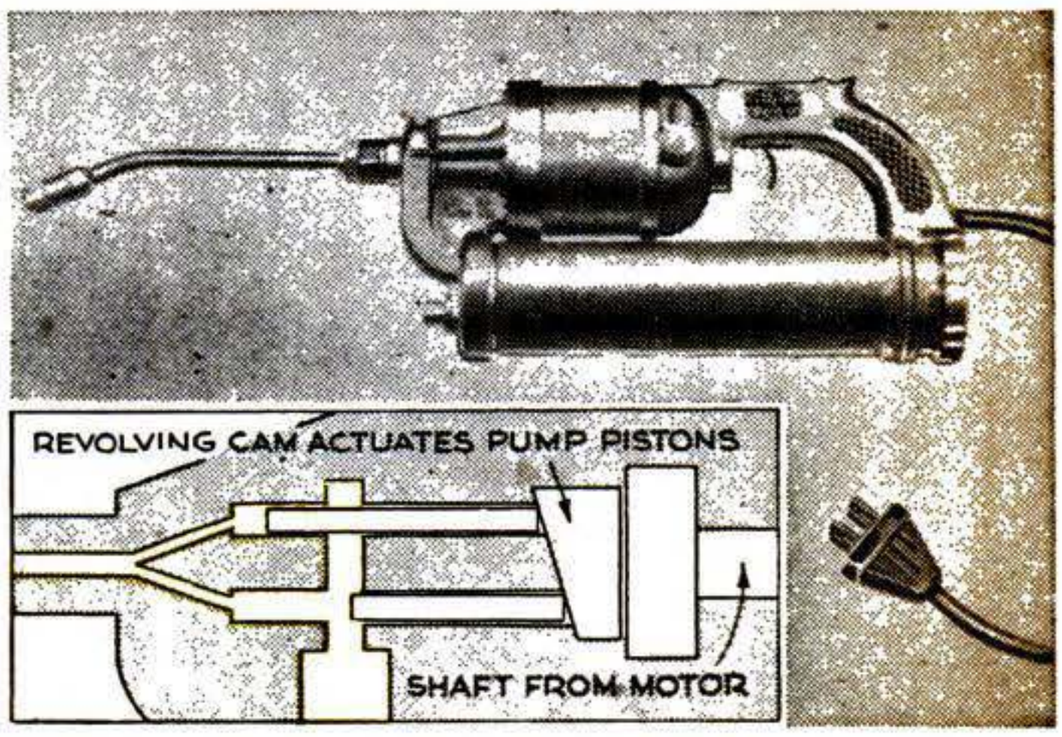




A ONE-BEDROOM CAR is the product of William M. Jones, a Camden, N. Y., mechanic who likes to take his wife and two children along when he goes fishing and hunting. He built the patchwork car shown above in his own welding shop with parts from Chevrolet, Buick, Pontiac, Studebaker, Terraplane, and Ford autos. It uses a Ford V-8 engine and a clutch operated by a bicycle chain and sprocket. Jones has a list of reasons why he prefers the engine in the rear: the driver has a clear view of road, the car is cooler in summer and free of engine fumes, and the rear wheels have good traction. If you'd like to build one for yourself, you'll need your own welding shop, a shrewd eye for buying parts from a junk yard, $250, and two months of work.

HYDRAULIC SHOCK ABSORBERS will appear on some motorcycles now scheduled for production. Mounted between handle bars and front-axle fork, the absorber damps out road shocks. Monroe Auto Equipment Co., Monroe, Mich., is the manufacturer.





ELECTRIC GREASE GUN. With a motor to do the work, this gun forces out grease at a pressure of 10,000 lb. per sq. in. The motor turns a cam that works four pistons (insert above shows two), pumping grease from the 1-lb. magazine. By using aluminum, John W. Hobbs Corp., Springfield, Ill., cut the weight to 7 lb.

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GUS Wins

FRED SPRATT, the portly chief of our town's Volunteer Fire Department, rushed into the Model Garage shop out of breath and with a scowl on his normally placid face.

"It's an outrage!" he yelled as he caught sight of Gus Wilson. "It's the lowest, rawest, dirtiest trick I've ever—"

"Take it easy—you'll blow a gasket," Gus cautioned. "What's eating you?"

Spratt's red face turned purple. "I'll tell you what's eating me!" he roared. "That double-crossing millionaire, W. Gilmore Westebrooke, is starting a ringer in the fire-engine race carnival!"

"Oh, that supercharged V-8 chemical wagon he's given Pleasantdale," Gus guessed. "It's still a piece of fire apparatus—"

"Fire apparatus, my eye!" Spratt howled. "It's a racing car with a trick red body bolted on. That's what it is!"

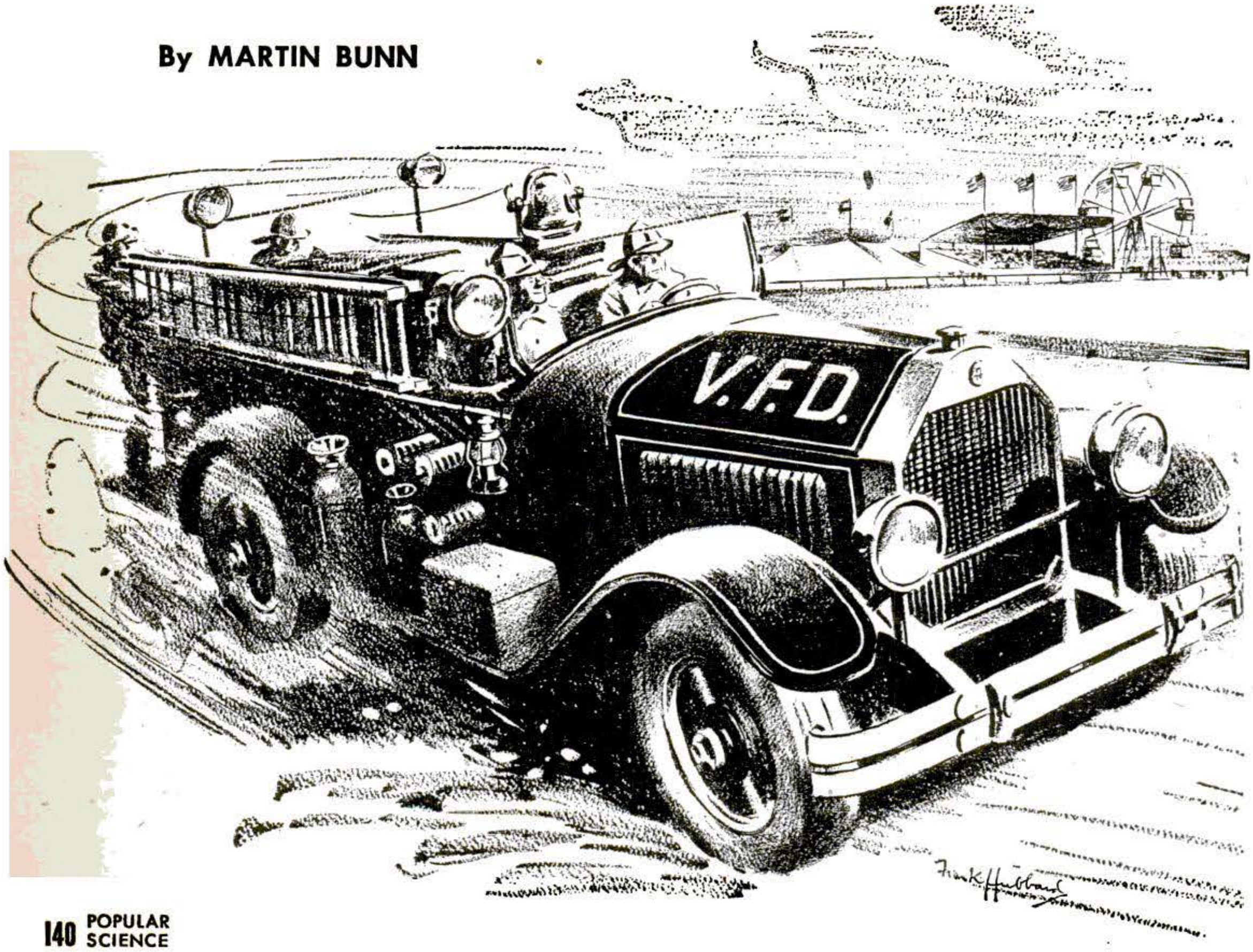
Gus grinned. "Oh, it's not as bad as that, although maybe it isn't quite as rugged as a working fire buggy ought to be. But as soon as it's gone to a few fires it'll qualify under the conditions of the race, and that leaves us just one thing to do."

"What's that?" Spratt snapped. "You tell me!"

Gus's grin widened. "We can tune up our truck so she'll go faster." He smacked his big hand down on Spratt's fat shoulder. "Syd Randall's been driving our old wagon to fires for a long time, and I've been nursing it just as long, and I know its engine still has plenty of power and pep. We've got two weeks before the carnival. You tell the boys to bring the truck here as often as possible."

The day of our Volunteer Fire Department's annual carnival ranks with Christmas and the Fourth of July. In the morning the visiting fire companies roll into town with sirens screeching and bells clanging, and in the afternoon there is the firemen's parade from the firehouse on Railroad Square to the Fair Grounds, with half a dozen bands blaring away. Then there's the barbecue supper, and after that the carnival—an evening of fun, spectacular exhibitions and com-

By MARTIN BUNN



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Against a Sure Thing

petitions under floodlights, netting a profit to meet some of our V.F.D.'s needs for the year.

But the climax comes in the afternoon—the fire-engine race between our department and Pleasantdale's. It grew out of a rural conflagration to which both departments were called. A never-decided argument over which made the better time induced Josiah Hadley to put up a big silver challenge cup for an annual race between them.

The first contest for this trophy was a road race that almost resulted in a bad accident, so the race was switched to the Fair Grounds. Because the unbanked turns of the old half-mile trotting track make car-to-car racing dangerous, the event is run in two two-mile heats against time, the truck with the fastest average being the winner.

For seven years Syd Randall's expert driving and Gus's ability to keep our aging truck tuned up as good as new had given us the race, and we got into the habit of regarding the Hadley Cup as a permanent ornament in our firehouse. Then Westebrooke, a playboy who makes fire fighting his hobby, was elected Pleasantdale chief.

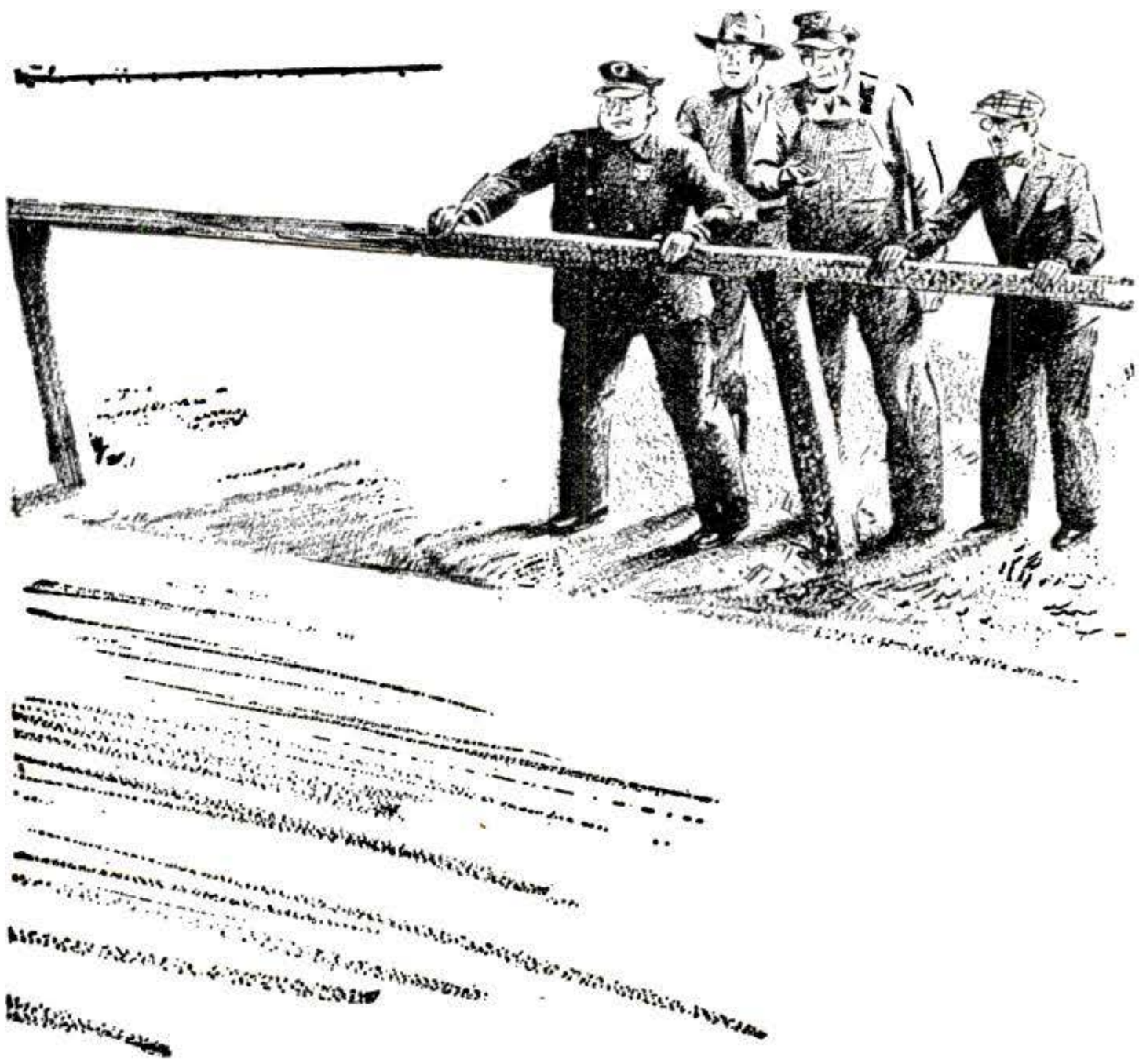
His new chemical wagon was obviously acquired just to take the Hadley Cup, and stories about its speed began to circulate. Doc Marvin told that it had overtaken him while he was doing 70 on an emergency call. State Trooper Jerry Corcoran watched it once and estimated it hit at least 90. We all figured the Hadley Cup was lost to us by a sneak play. All but Gus—he just grinned and spent his evenings overhauling and tuning up our old truck until, late the night before the carnival, it was adjusted as accurately as an expensive watch.

"The old gal will go as fast as ever," he told some of us who had come around for a final look. "All I hope, Fred, is that you won't have to take her out tonight."

"Not even if the Mayor's house burns," Spratt assured him. "You've done a swell job, Gus. But I'm afraid we're sunk against that ringer of a camouflaged racing car. I hear Westebrooke is going to drive himself."

"He's good, too," Gus remarked. "Ought to be—he's rich enough to spend all his time practicing. But Syd is good, too." He yawned, and we took the hint and went home to bed.

Syd capitalized on being first around the unbanked curve and took it fast. His wheels bit deep, tossing up a spray of dust and mud.



AFTER the lesser events of the day, the grandstand was packed for the climax, the Hadley Cup race. Gus was in the crowd of officials in front of the judges' stand.

"You all know the rules," the referee barked. "Two two-mile heats against time from a standing start. Shortest total time wins. Vehicles to carry their regular equipment and full crews. Winner of the toss goes first in the first heat and last in the second."

Spratt won the toss. There was a roar of cheers as our old truck rolled to the starting line. Gus went over to speak to Syd Randall, a mild-mannered man who clerks in a grocery store but who is a second Ralph De Palma when

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he gets his foot on an accelerator. "Take it easy on the turns, Syd," he advised. "The track looks dry, but under the surface it's as soft as mush."

Syd nodded. "I'll watch," he promised. "Those turns will be cut up something fierce after we've been round a couple of times."

"Ready, Randall?" the starter shouted. Syd nodded. The flag swept down.

Our crew yelled. The crowd roared. So did the engine as our truck shot away from the starting line and thundered to the unbanked turn. Syd capitalized on being first around and took it fast. His wheels bit deep, tossing up a spray of dust and mud. The crowd gasped, and then it yelled. Syd was safely around and streaking up the backstretch. Another gasp as he hit the second turn; another curtain of dust and mud; another sigh as he got safely around.

"Easy—take it easy!" Gus begged under his breath. Syd seemed to hear. He slowed on the turns on each of the three other laps; then gave her the gun down the homestretch for a finish that had everyone yelling. His time was posted—1:59 3/10.

For 10 minutes tractor-drawn scrapers smoothed down the cut-up turns. Then the Pleasantdale chemical wagon was driven to the starting line and given the flag. Westebrooke played safe on the turns, but his car was so fast that he easily made up for it on the stretches. Even our townsmen cheered when his time went up—1:55 flat.

There was another wait while the turns were manicured. Then Westebrooke raced his second heat. He was even more cautious on the curves, but his time was 1:55 3/10. Gus was near him when he got out. "The turns were so soft I had to crawl around them and waste half my speed," he explained. "Well, Randall can't take them any faster."

"Can't he!" Gus muttered. He hurried over to the improvised service pit. "You've got to do 1:50 9/10 to win," he told Syd. "I'll fix it so you can take the turns fast."

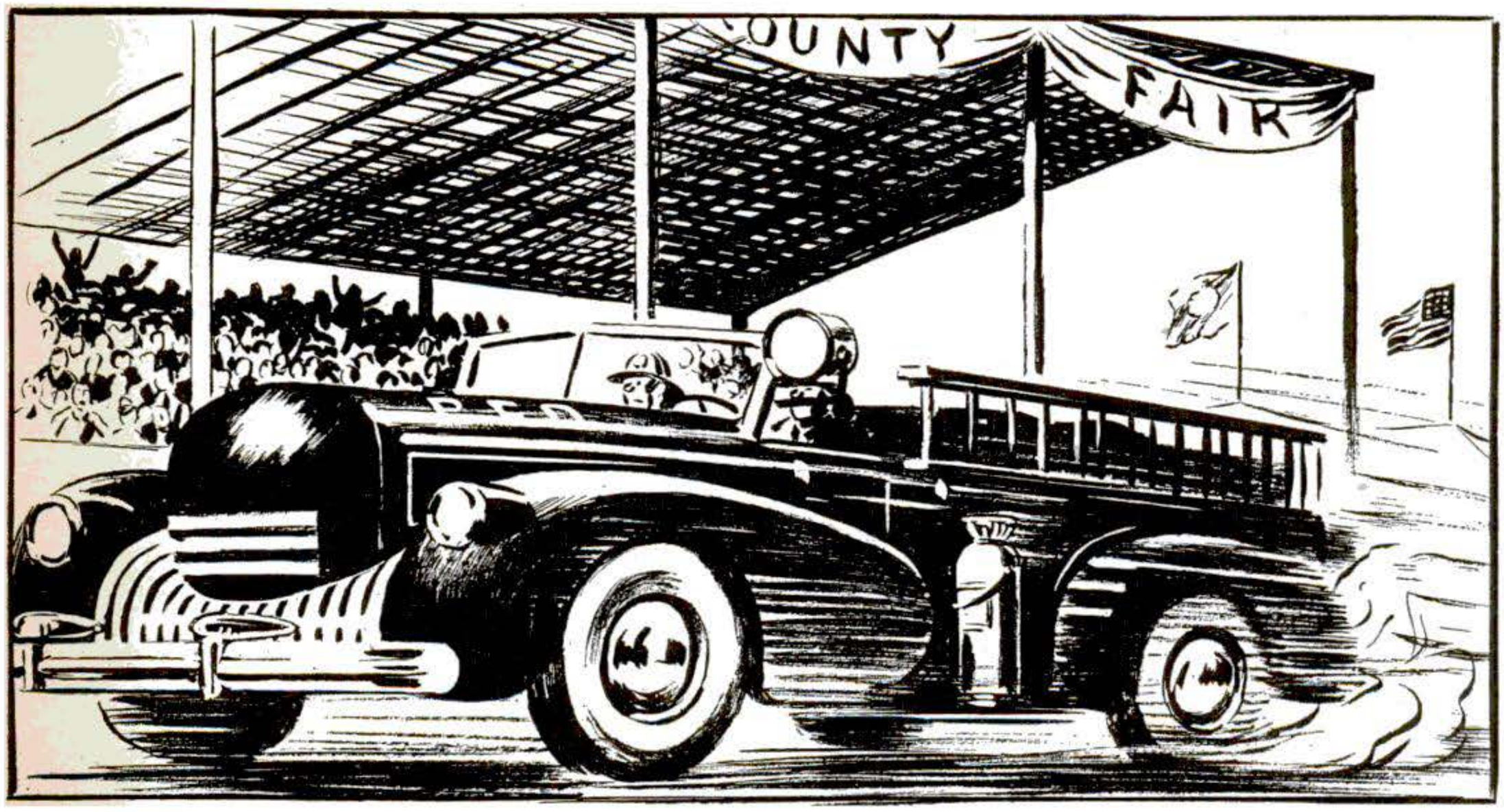
He took a tire gauge from his pocket, kneeled at the left front wheel, removed the valve cap, and let out 10 lb. of air. Then he did the same thing to the left rear tire, after which he told Stan Hicks, the Model Garage mechanic, to increase the pressure of each right tire by 5 lb.

"O.K., Syd," he said. "That's an old dirt-track trick. The partly deflated inside tires give you a tendency to bank left and overcome part of the curve sway. Give her all she'll stand without turning over!"

The truck roared away and went into the first turn much faster than either driver had attempted it before. There was a gasp from the crowd, and Gus Wilson's mouth tightened, but the truck didn't turn over. Four times around, a thunderous, heart-stopping rush for the finish wire—and Gus heaved a mighty sigh.

There was a tense wait. Then the time went up—1:50 9/10! The Hadley Cup was still ours—by a tenth of a second!

Even our townsmen cheered at the time made by the speedy Pleasantdale chemical wagon—1:55 flat.



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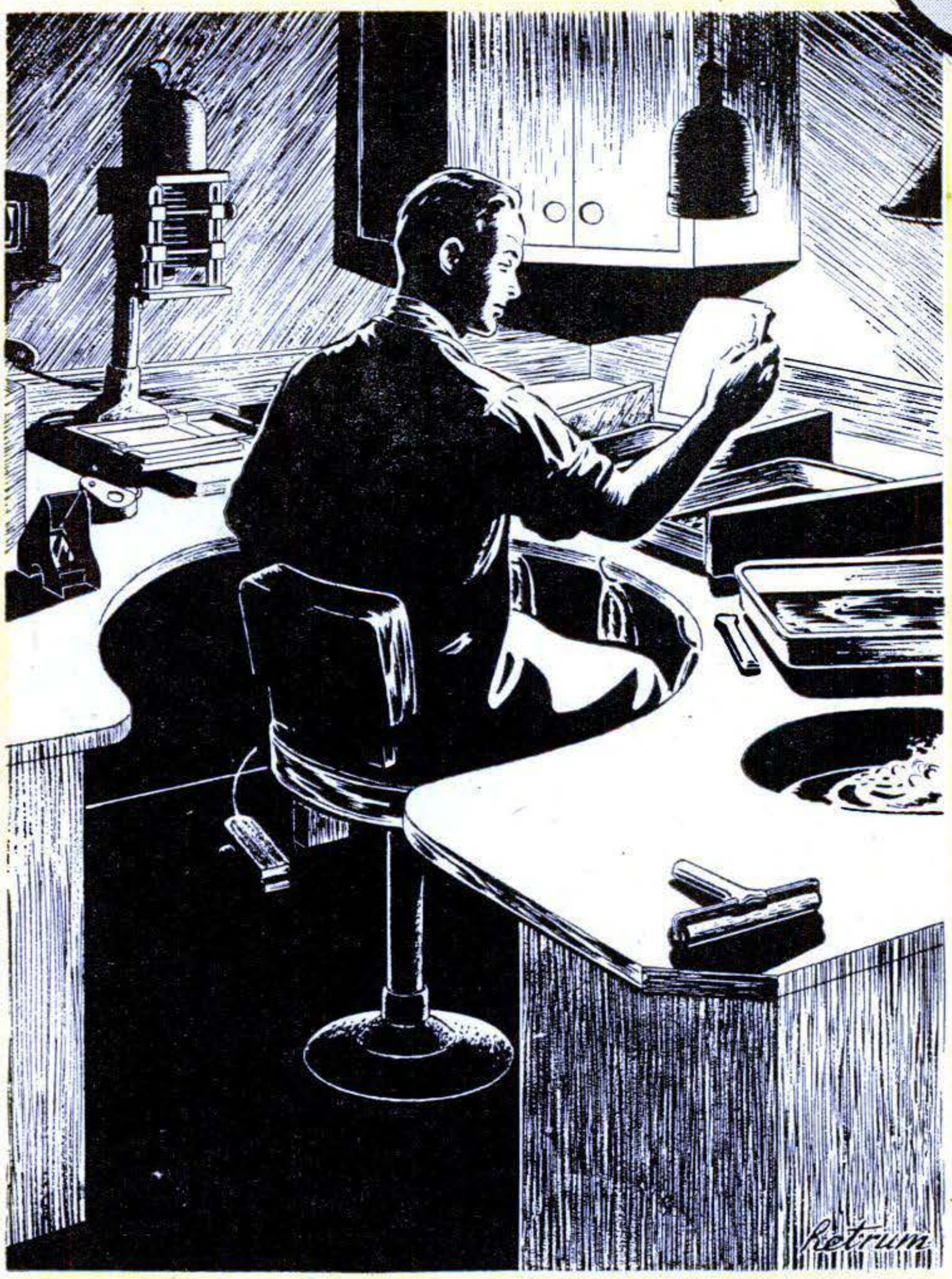
MECHANICS AND HANDICRAFT



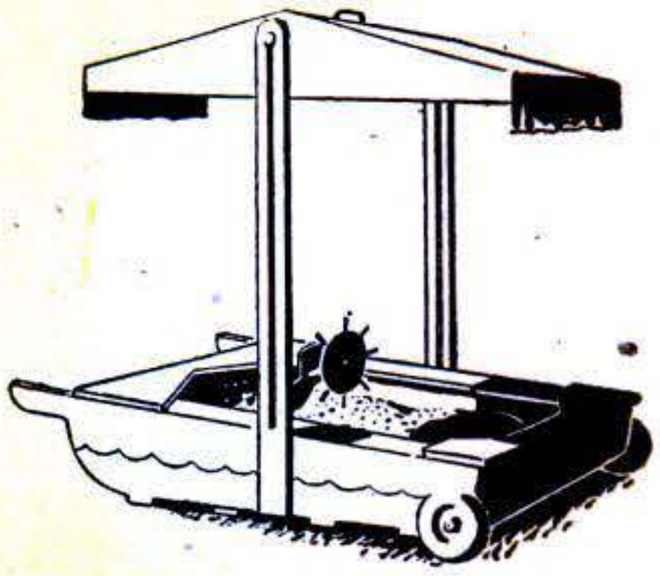
Antennas for New F. M. Band

Play-Yard Sandbox

Plastic Desk Accessories

Electric Drill Hints

Dream Darkrooms



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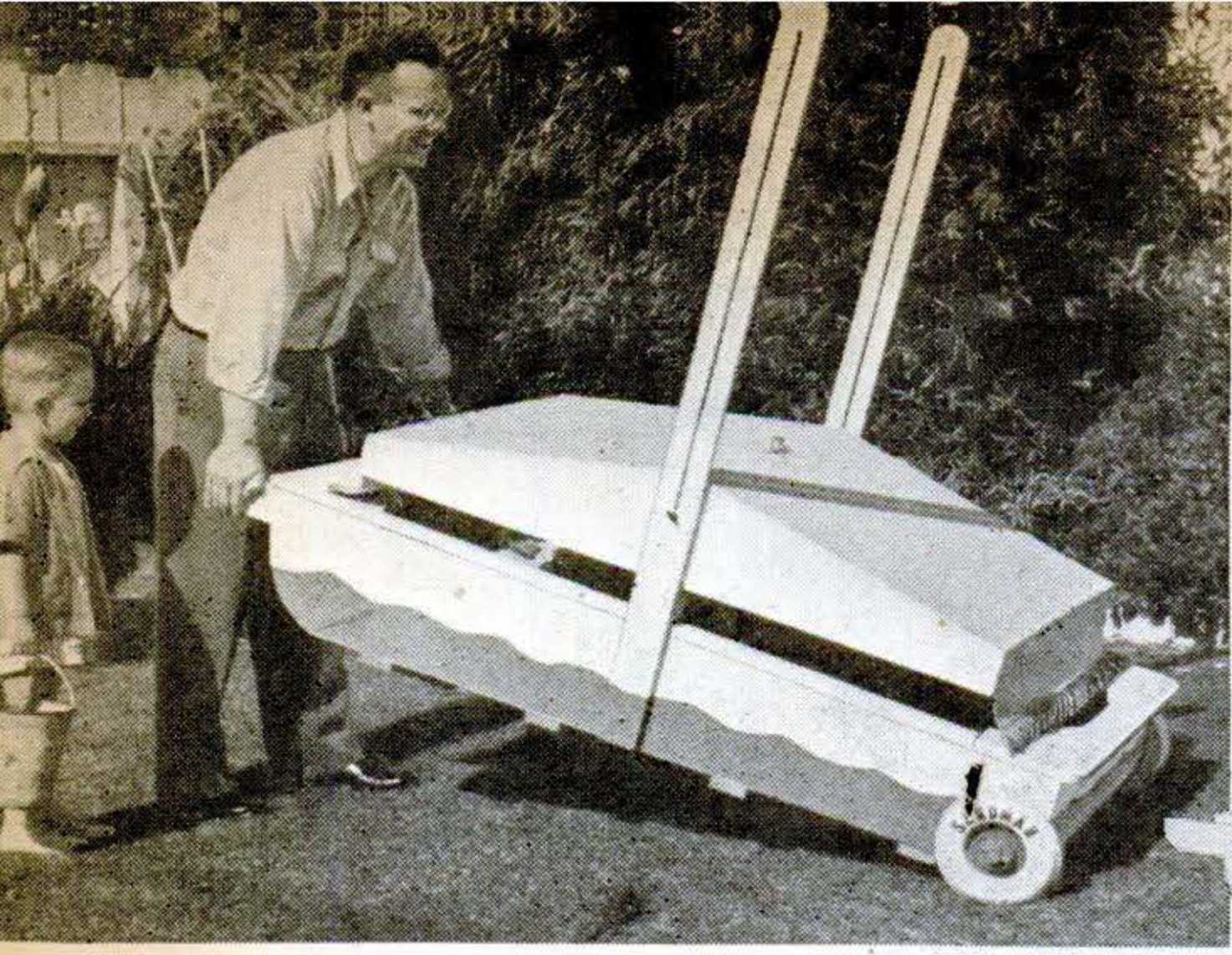

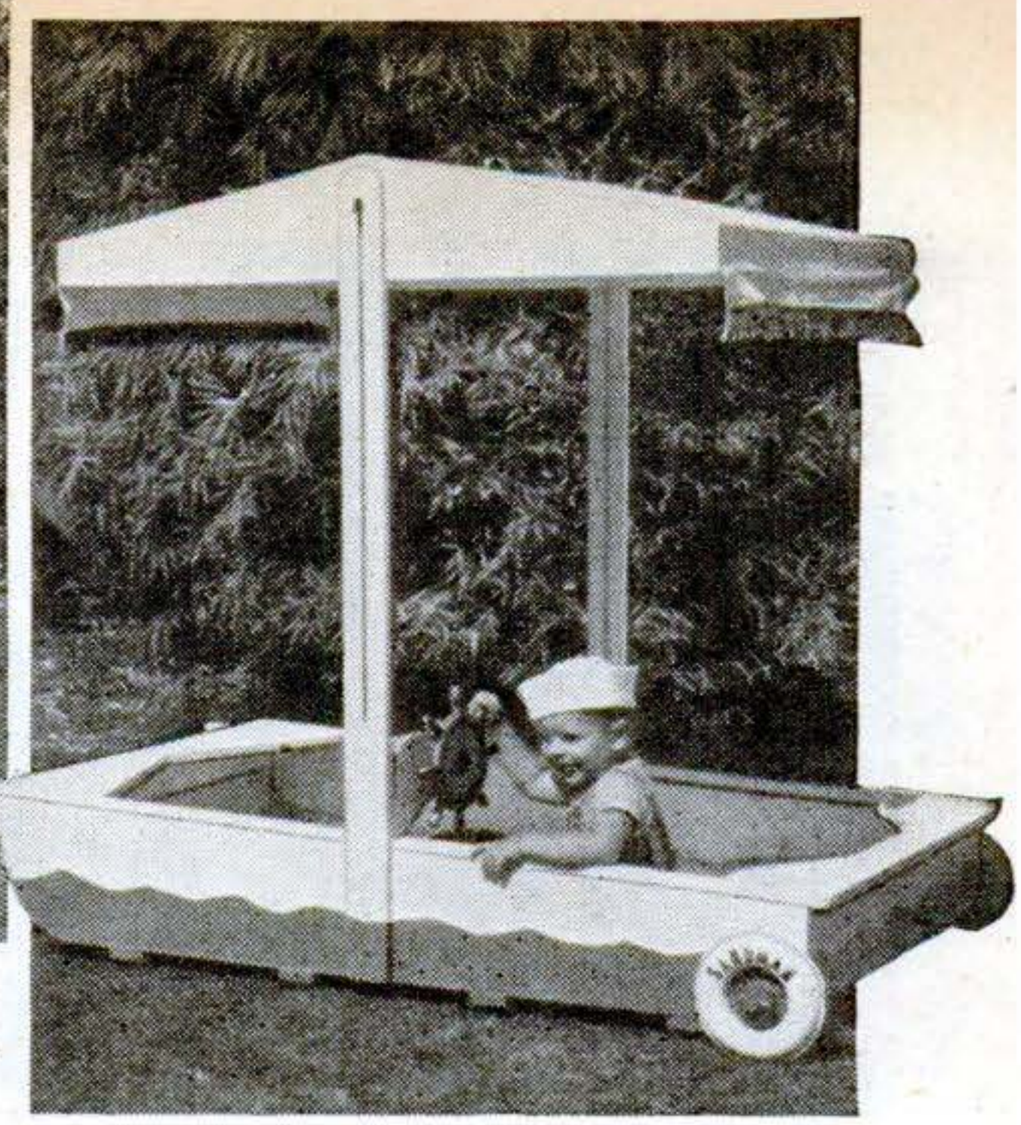

With a canvas canopy and "life preserver" wheels, the sand boat is protected from sun and rain and can be moved so no part of the lawn is constantly under cover.

SAND SCHOONER

for Play-Yard Skippers

SHIP ahoy, there, sailor! Here is a nautical sandbox that serves the double purpose of both beach and boat. It is mounted on two life preservers that do yeoman's duty as wheels when the box is to be pushed from spot to spot. A series of feet sawed into runners on the underside keep it high enough to permit circulation of air beneath. The two "bowsprits" are handles to help in moving the box about.

Any parent can build and paint the box in a few hours. The result ought to keep his offspring in his own back yard all summer—probably with half a dozen neighbors' kids as well.

Make the frame first, as shown in the drawings, sawing the short handles as part of the sides. Note that the ends are of different width boards, one 3″ and the other 6″, joined to the sides with brass screws and waterproof glue. The 3′ wide sheet-metal bottom is cut 6′ long to bend up and cover the ends. It is notched to pass the handles and should fold over the ends about 2″. Fasten it to the frame with long, flathead box nails. Then nail on the top boards that form the corner seats, and fair up the sides with ¾″ by ¾″ strips.

Four crosspieces are nailed to the bottom for support, and three runners, band-sawed as shown in a photograph, are notched into them.

Turn the wheels from hardwood to the shape shown, or build them up of wooden disks, and drill the center holes to fit easily on the axle, a 42″ length of 1″ hardwood dowel. Paint the wheels and staple on sash cord for decoration.

The slotted uprights are bolted on for easy removal when the box is to be stored for the winter. Holes drilled for the ends of the slots provide stops either for table or hand sawing. Reinforce the top ends with two dowel pins glued in as shown.

Saw the sides of the canopy from ¼″ plywood or composition board, and nail in crosspieces no more than 35¼″ long so the canopy can slide between the uprights. Then tack on the canvas. Use one or two bolts, washers, and wing nuts on each side.

Turn the helm from a solid piece 7″ in diameter, and turn and glue in spokes shaped from ⅝″ dowel. Mount with washers as spacers on a piece of 7/16″ dowel. Assemble the wheels on the axle also with washers and insert dowels as retainers. Nail the axle on.—LECIL J. SLABACK.

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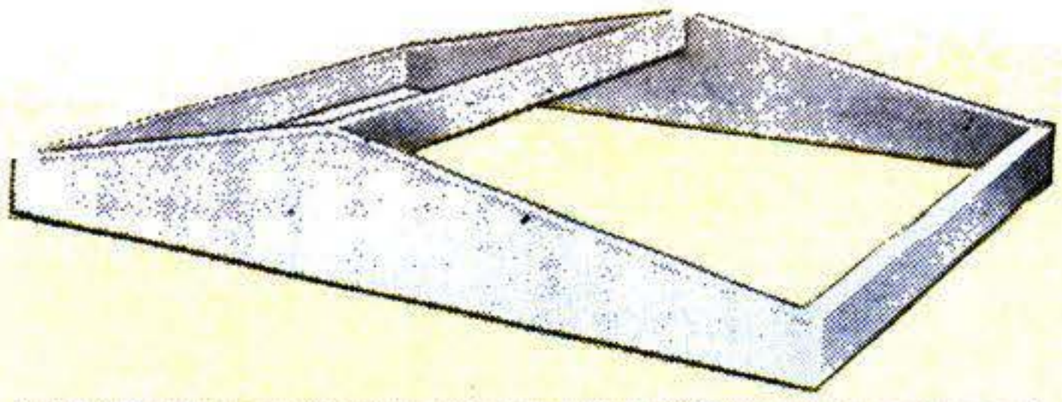
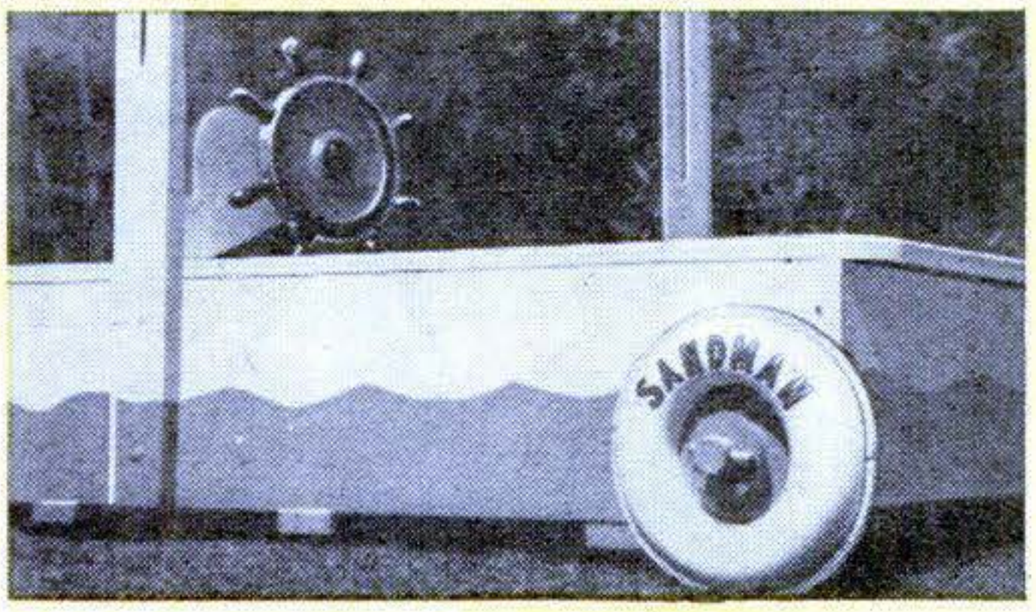
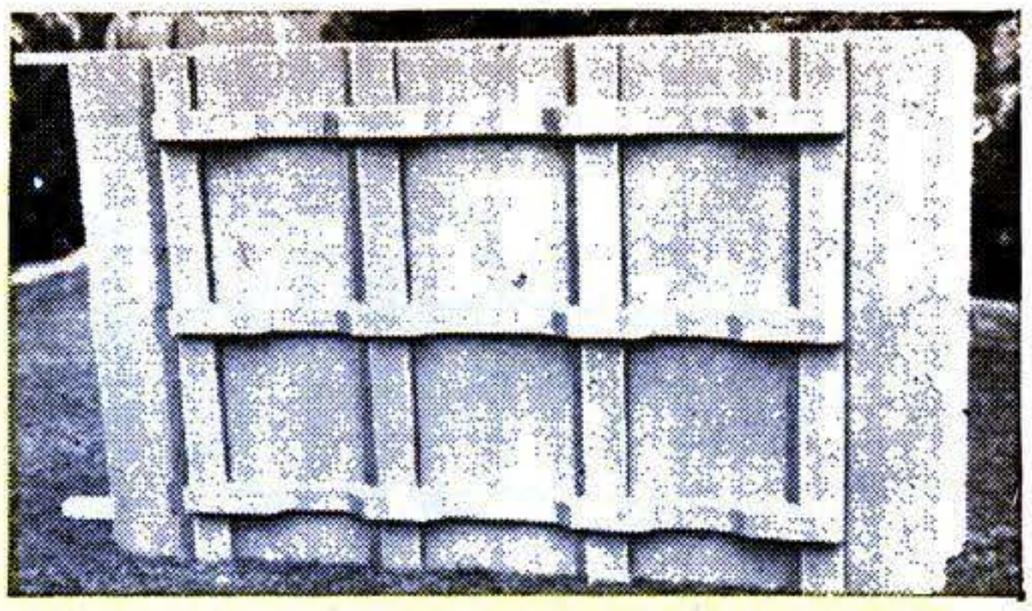


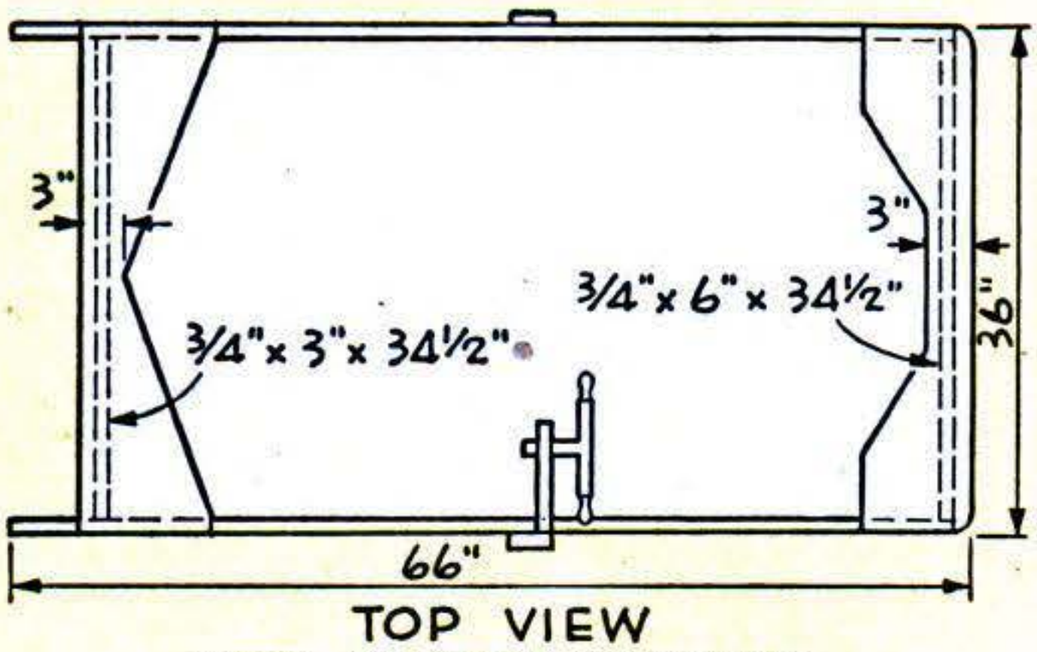




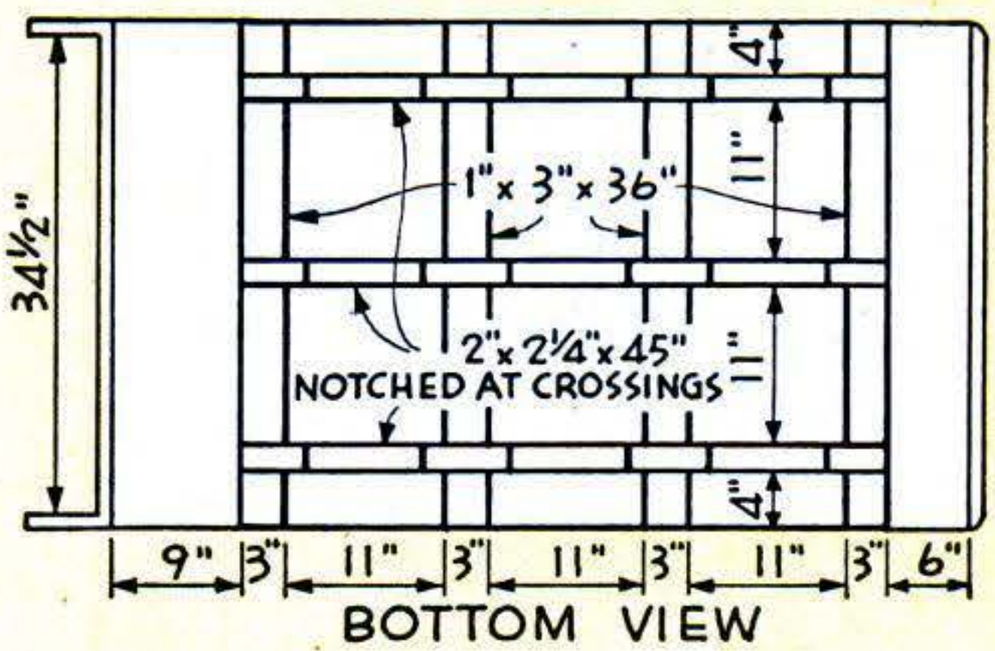
Crosspieces and runners support a sheet-metal bottom. Runners are bandsawed to form feet.

At left, a view of the box showing one wheel. The helm is mounted on one of the two uprights.

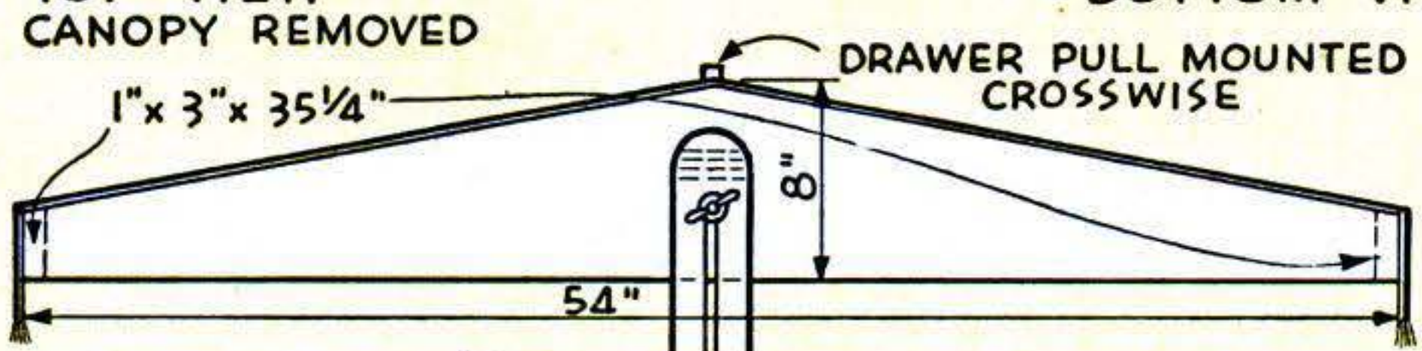
Construction details are given in the drawings below. Most of the wood required is ¾" stock.

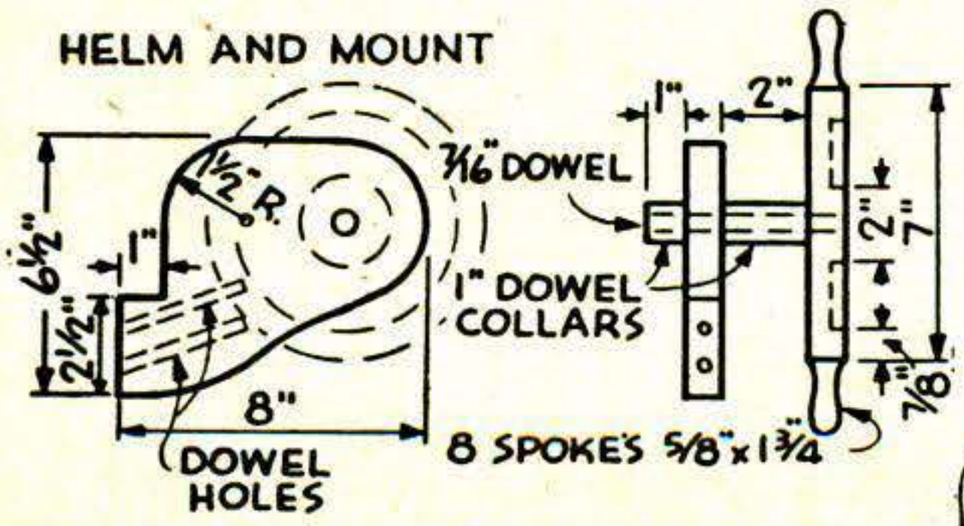


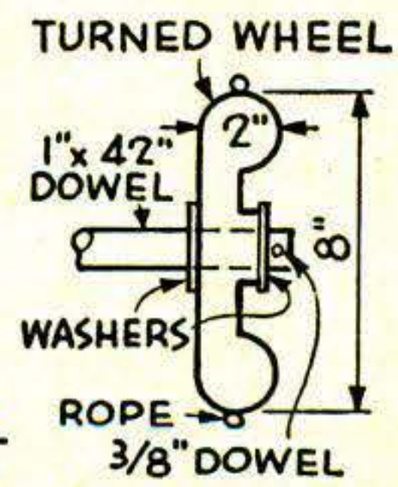
TOP VIEW
WITH CANOPY REMOVED

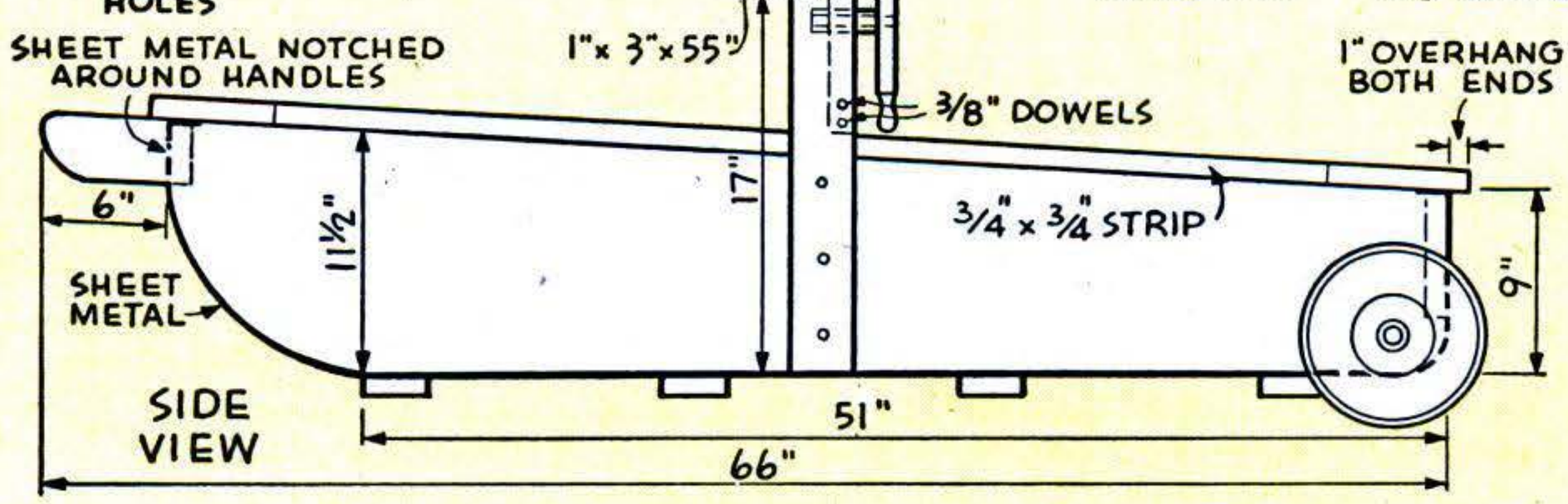


BOTTOM VIEW









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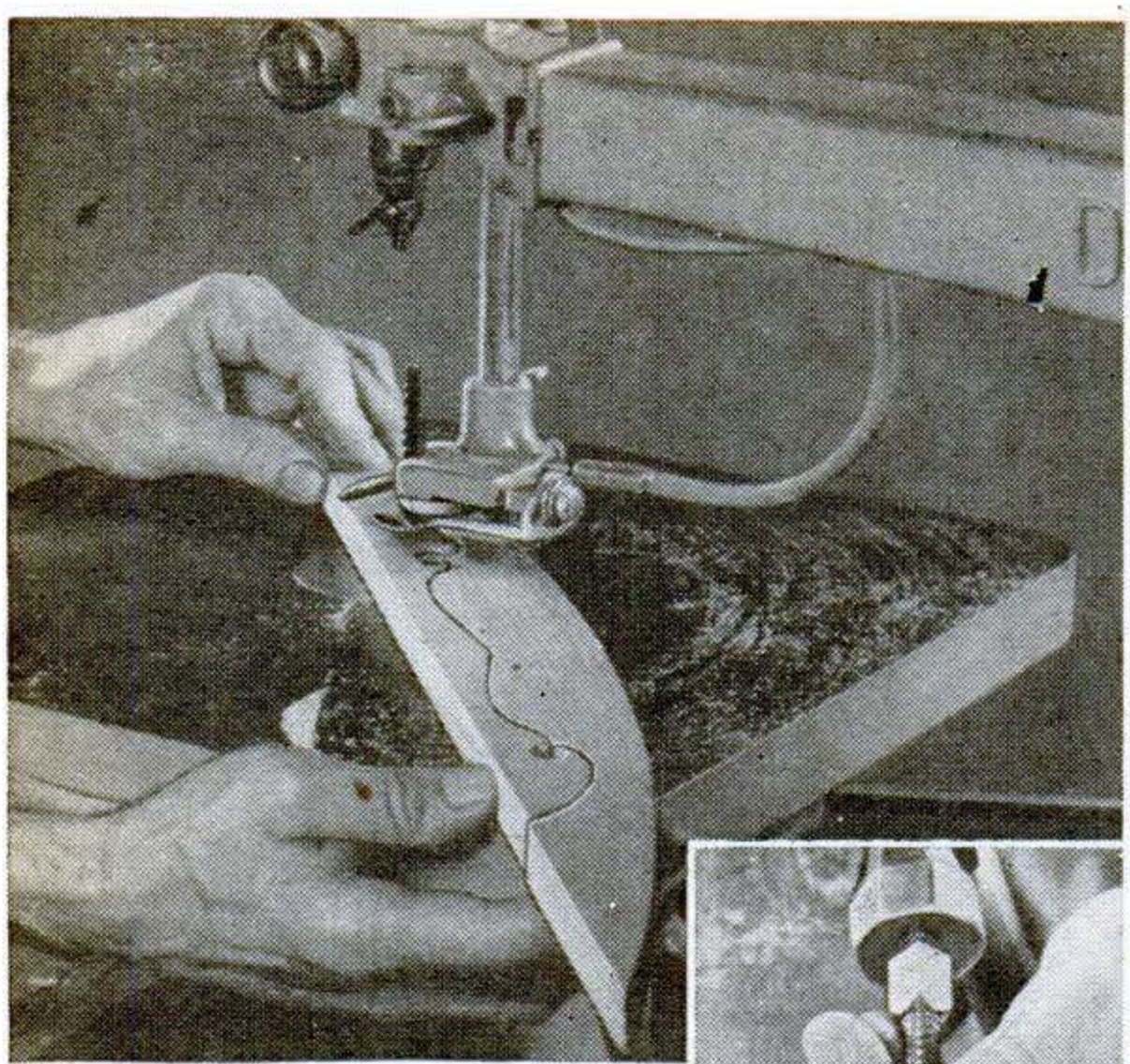
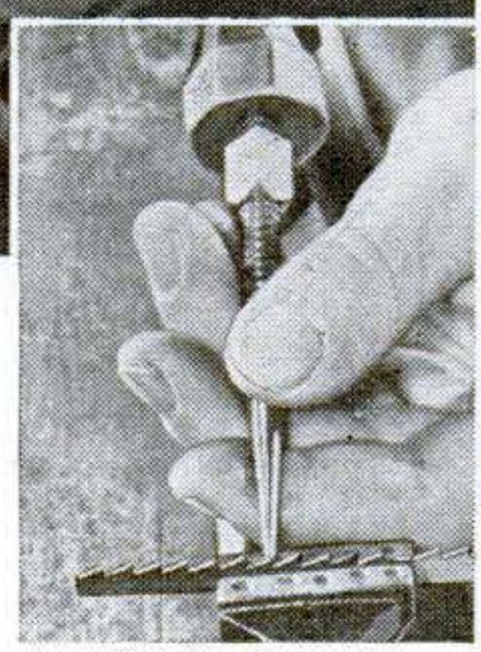
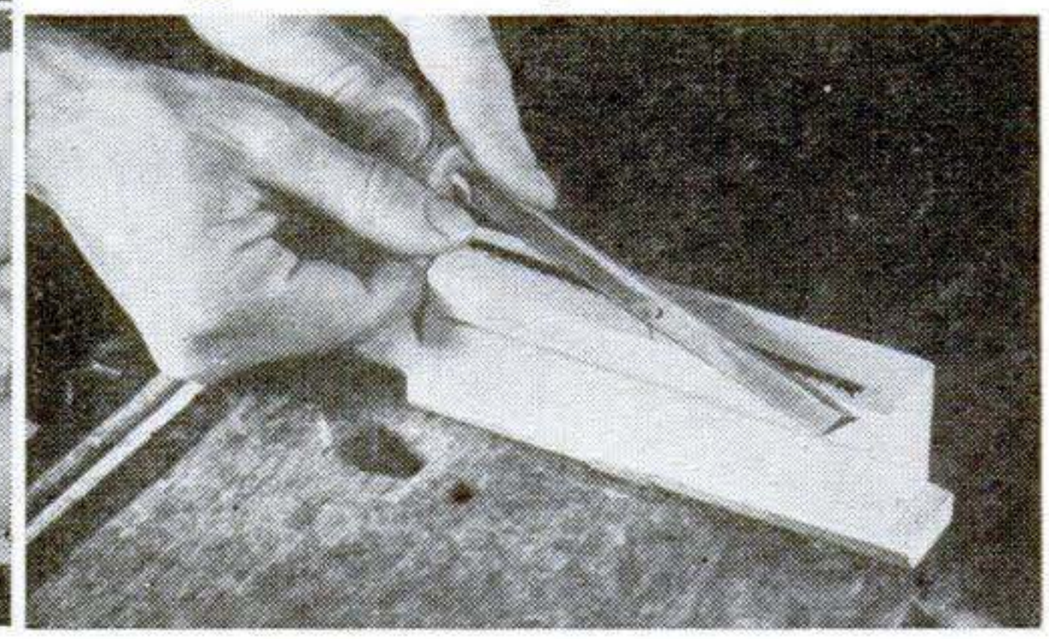
Saber Blades Will Cut Sharp Curves If Teeth Have Extra Set



WITH a few modifications, heavy ¼" saber blades can be used, as at the left, to cut sharp curves. Clamp the blade in a vise and increase the set of the teeth to about twice the normal amount, using a punch. Strike lightly to avoid breaking. Next place the blade flat on a block and file the teeth lightly on both sides. This evens the set and replaces scratchy corners with sharp edges that smooth the cut. Finally, file the teeth straight across. Circles as small as ½" in diameter can be negotiated when the blade has been changed in this way.—E. M. L.



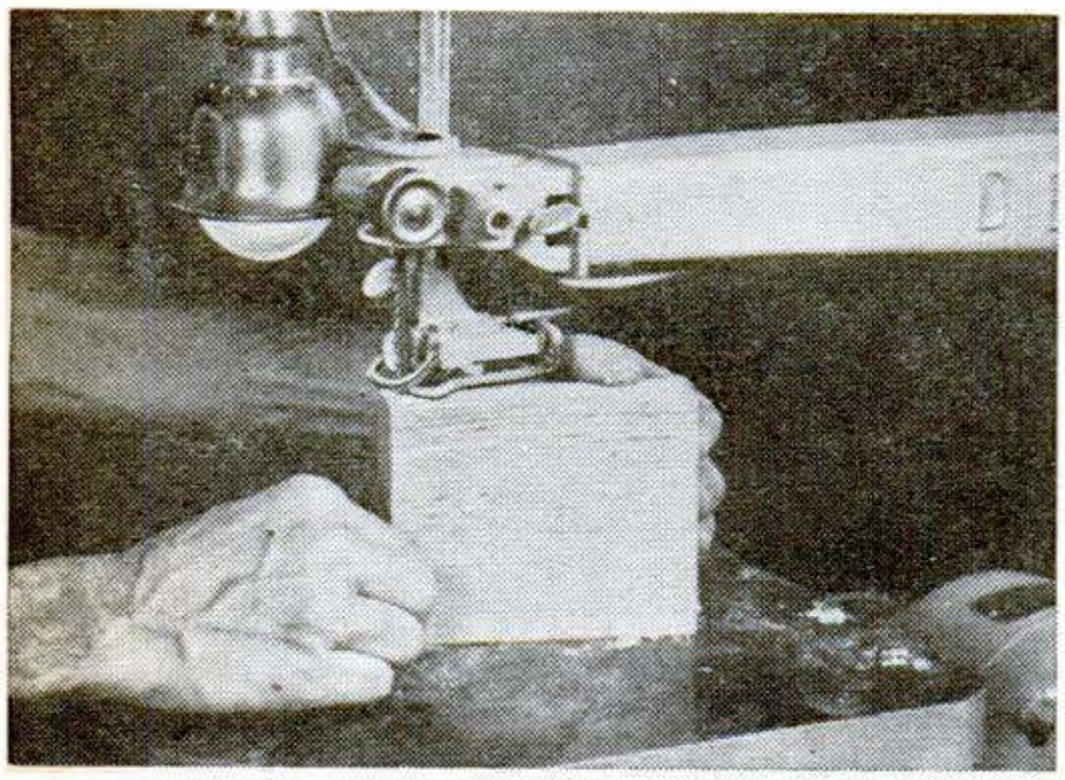


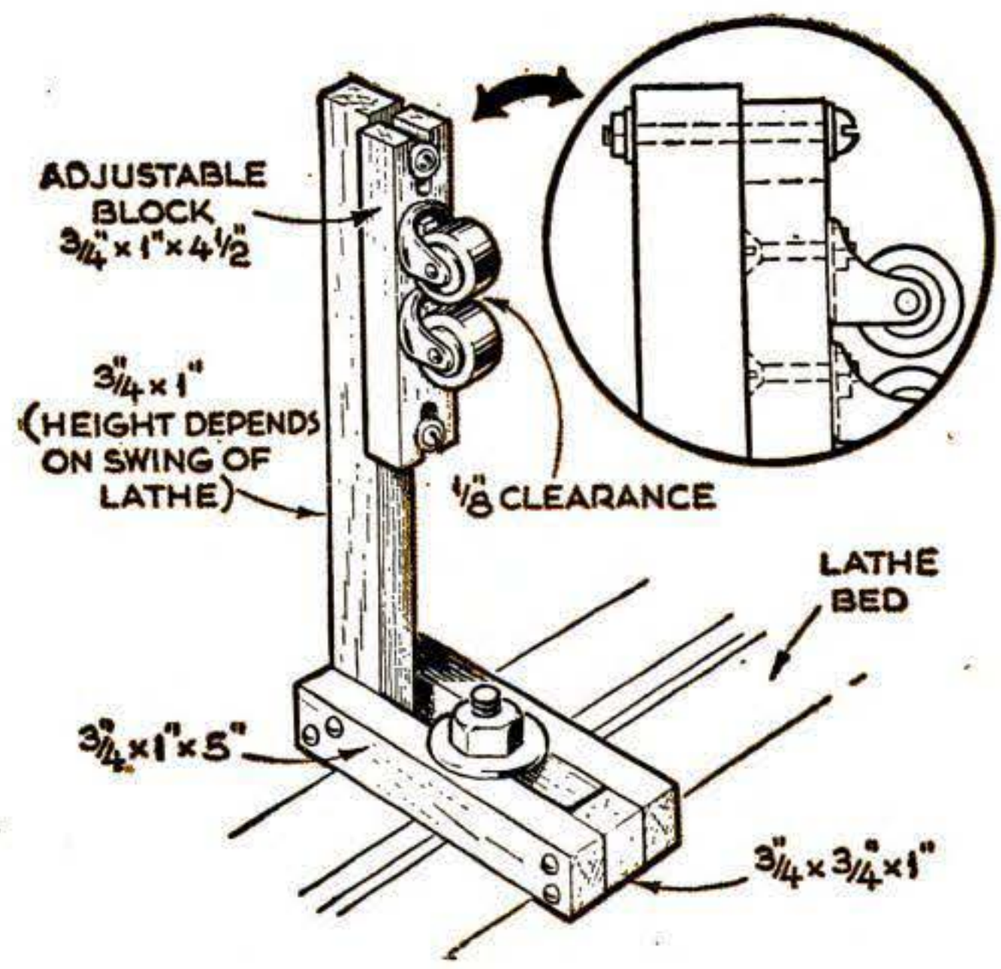
Double the amount of tooth set by driving with a nail punch as in the first photo at the right, using light blows. A few strokes of a file, far right, bring the teeth to side alignment. Sharpen them by filing square across.

Jigsaw Cuts Thick Stock After Removal of Spring Return

HEAVY stock can be cut on some of the larger jigsaws merely by removing the spring-return assembly from its clamp to provide clearance for a double-length saber blade. This makes it possible to saw stock up to 4" in thickness, as shown below.

Saber blades for this purpose can be quickly made from sections of large band-saw blades. File the teeth sharp and your blades are ready for use.—E. M. L.





Casters Steady Work on Lathe

SWIVEL casters mounted at the back of a wood lathe as above will keep long slender spindles from vibrating while they are being turned. The length of the upright may be determined by measuring the distance from the lathe bed to the center of the spindle and allowing enough more for attachment of the adjustable block.—R. S. W.

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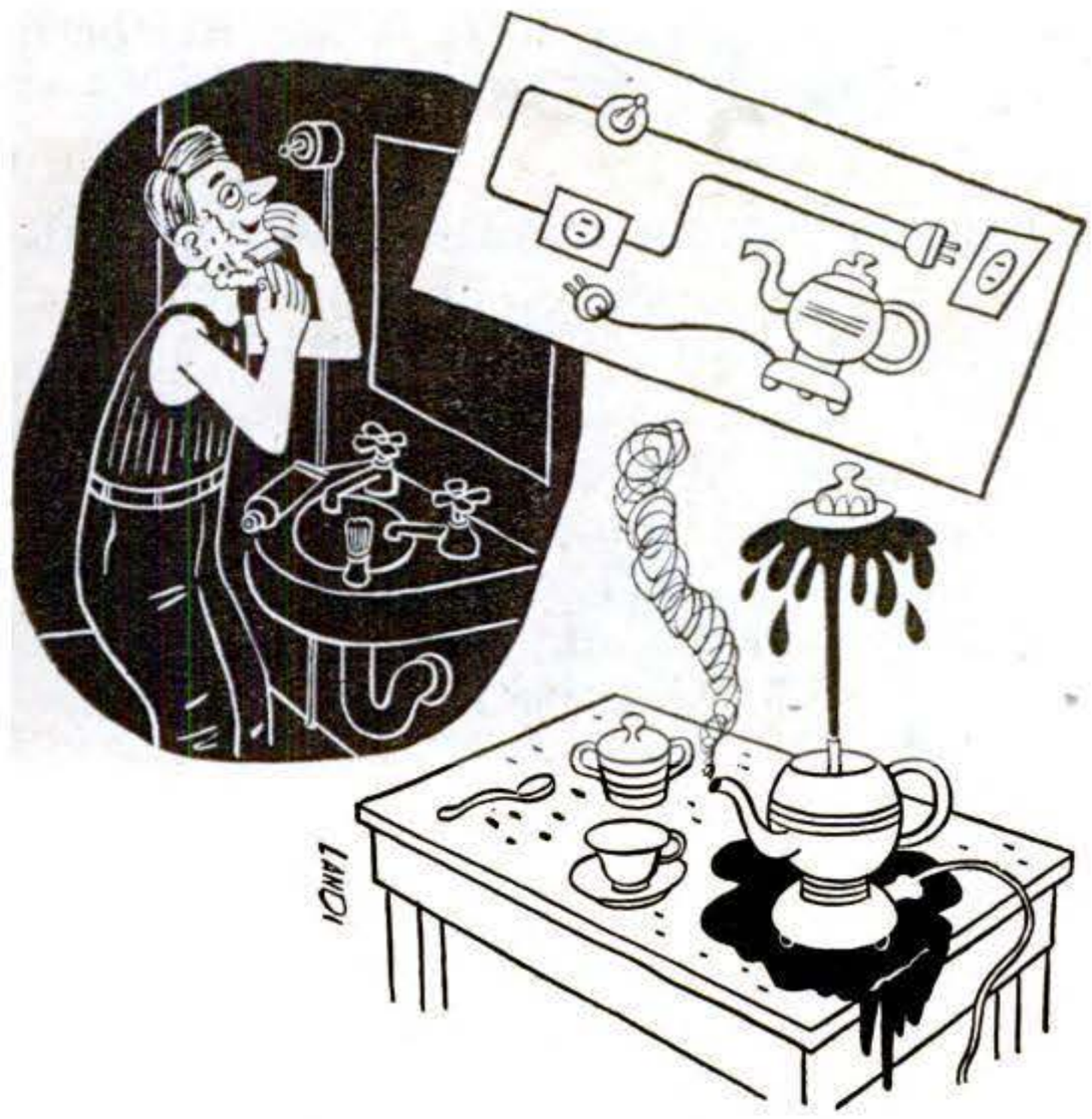
What's Your Ingenuity Quotient?

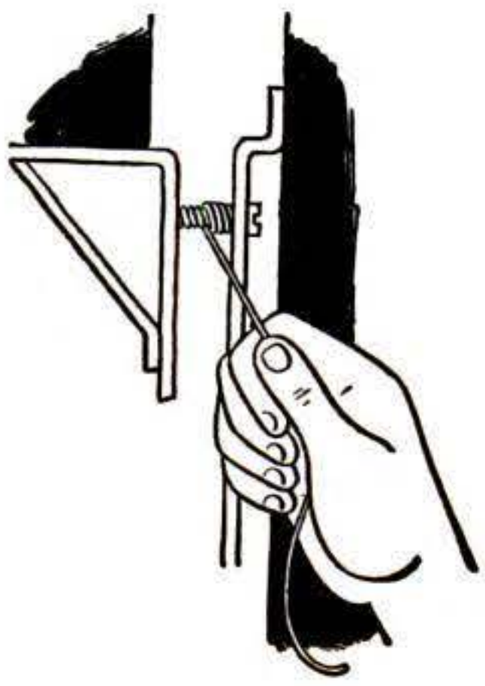
Have you pulled off a smart one lately? We will pay for each contribution accepted for this page showing ingenious soutions of problems in the home, shop, garage, or camp. It doesn't matter if it's wacky—if it works.



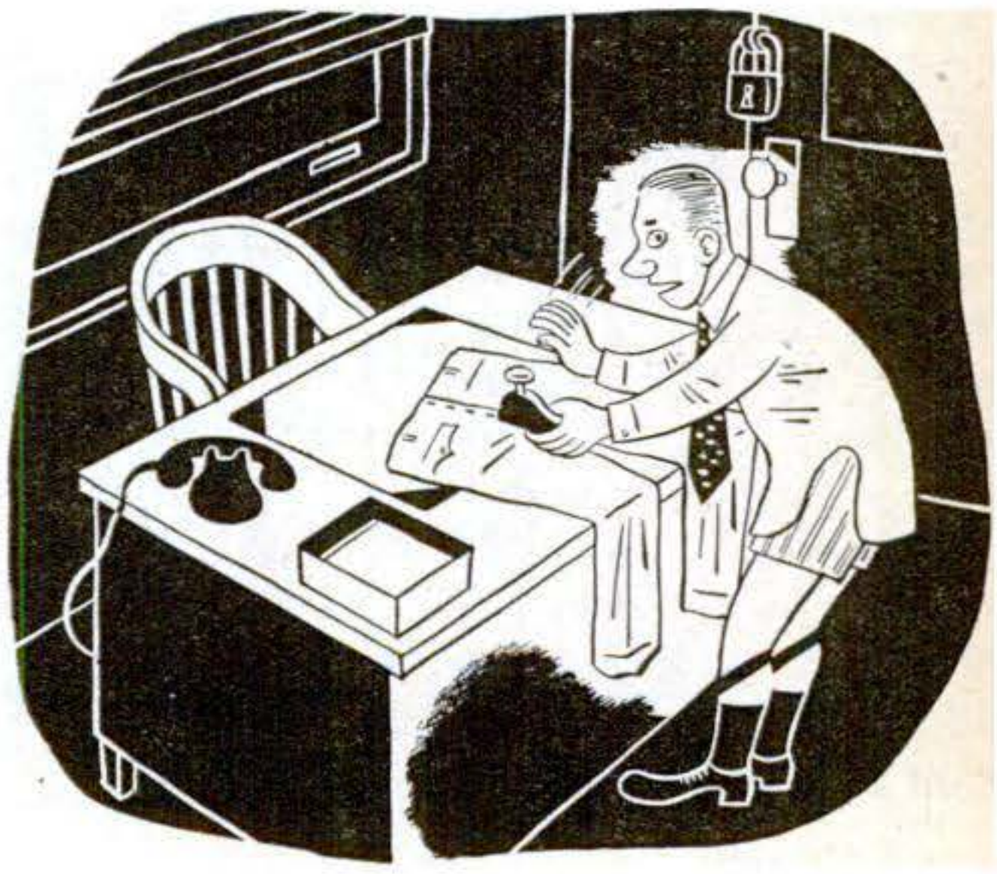
IT GOT IN MY HAIR when I had to stop writing music to draw a new sheet full of staffs. But even when ruled sheets weren't to be had, ideas were. Mine consisted of breaking off some of the teeth of a pocket comb, leaving groups of five. Drawn over carbon paper, the teeth leave an imprint on a sheet underneath.—Henry Withers.

CAUGHT WITH YOUR PANTS DOWN? My predicament was almost as bad. One day at the office I bent down while my trouser seam didn't. This might have left me exposed to ridicule if I hadn't thought of my stapling gun. Behind closed doors, I clipped in a new seam in no time at all. I stood for the rest of the day.—R. Card.

SHAVING TIME in the morning is what you make of it. I make mine coffee-brewing time, too. Instead of running up and down the stairs to set my electric percolator perking, I wired in this extension between my kitchen and upstairs bathroom. With coffee and water prepared the night before, all I have to do is flip the switch between razor scrapes, and coffee and I come down to breakfast together.—Corwin Robbie.



TWO HANDS aren't always enough, as I discovered when I had to start a screw in a narrow crevice while supporting the apparatus with one hand. A piece of string proved to be the answer. After placing the parts, a pull provides the first few turns.—B. L. DeMare.



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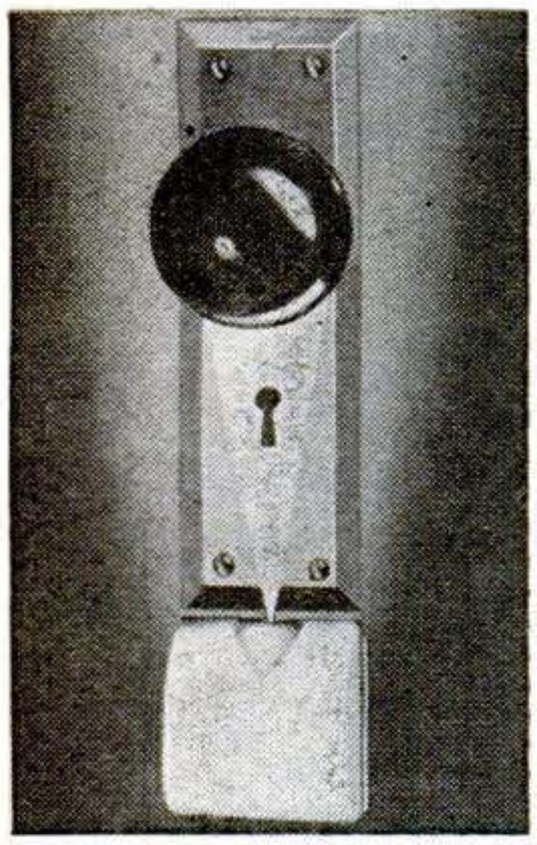
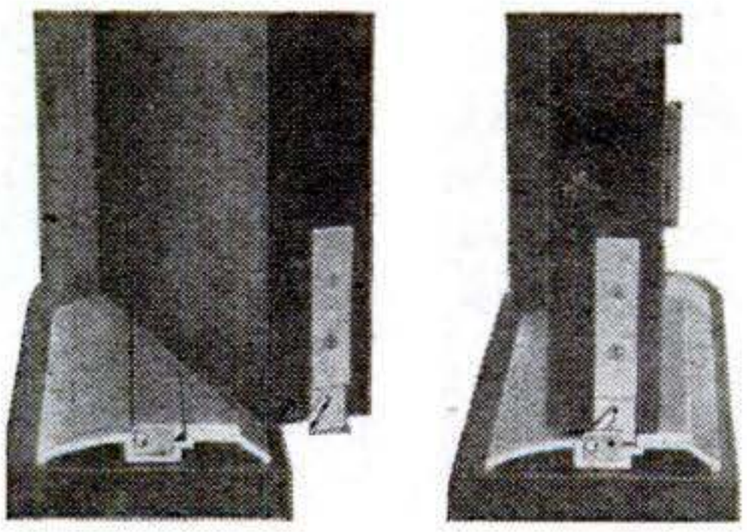
HOME OWNERS

DOUBLE ACTION AGAINST MOTHS is the aim of a new closet wallpaper that is both cedarized and treated with DDT. The lining paper is also effective against ants, flies, mosquitoes, silver fish, and other insects. Prepared paste on the back of the paper simplifies application, which requires only wetting in a tub and hanging. Trimz Co., Inc., of Chicago, is the maker.



KEYHOLE FUMBLING isn't excusable on doors equipped with the lock light shown above, made by the Home Products Co., of Chicago. It uses a standard battery and bulb, may be installed in five minutes, and cannot be left burning by accident or carelessness.

DRAFTS ARE STOPPED under doors fitted with Weather-Tite Door Saddles embodying an ingenious principle in weather-stripping. A saddle of aluminum alloy installed on the doorsill has a rising center strip; when the door is closed, a key engages the end of this strip, lifting it and sealing out air or rain. The strip lies flat when the door is open. Columbia Industries, of Long Island City, N.Y., is the manufacturer.



CLEAN BRUSHES are easy to have when they can be taken apart at the center, as above, for cleaning hard-to-reach paint on the middle strands. This two-part, plastic-handle brush was invented by Ernest L. Hawkins, of Chicago. Halves can be used alone.

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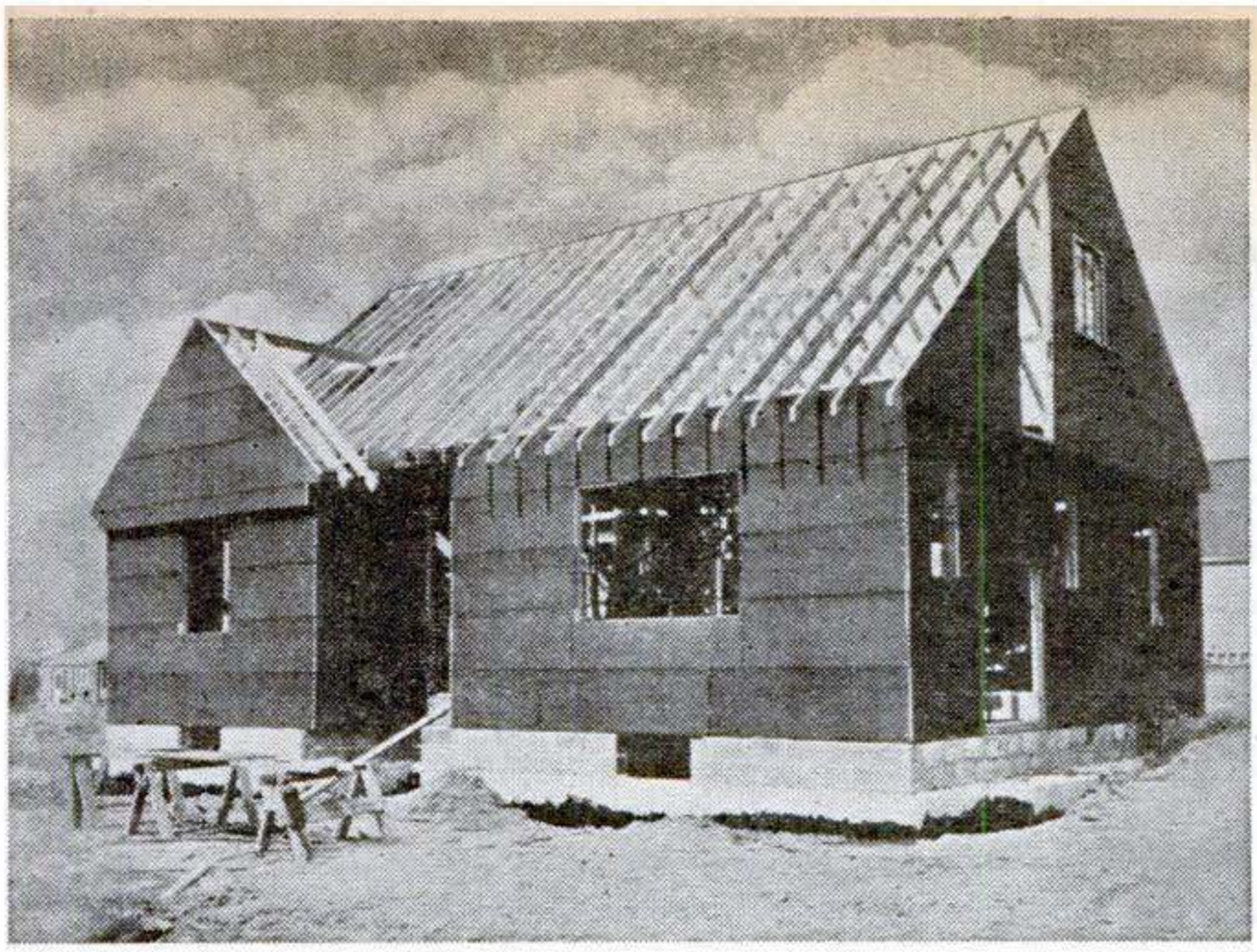
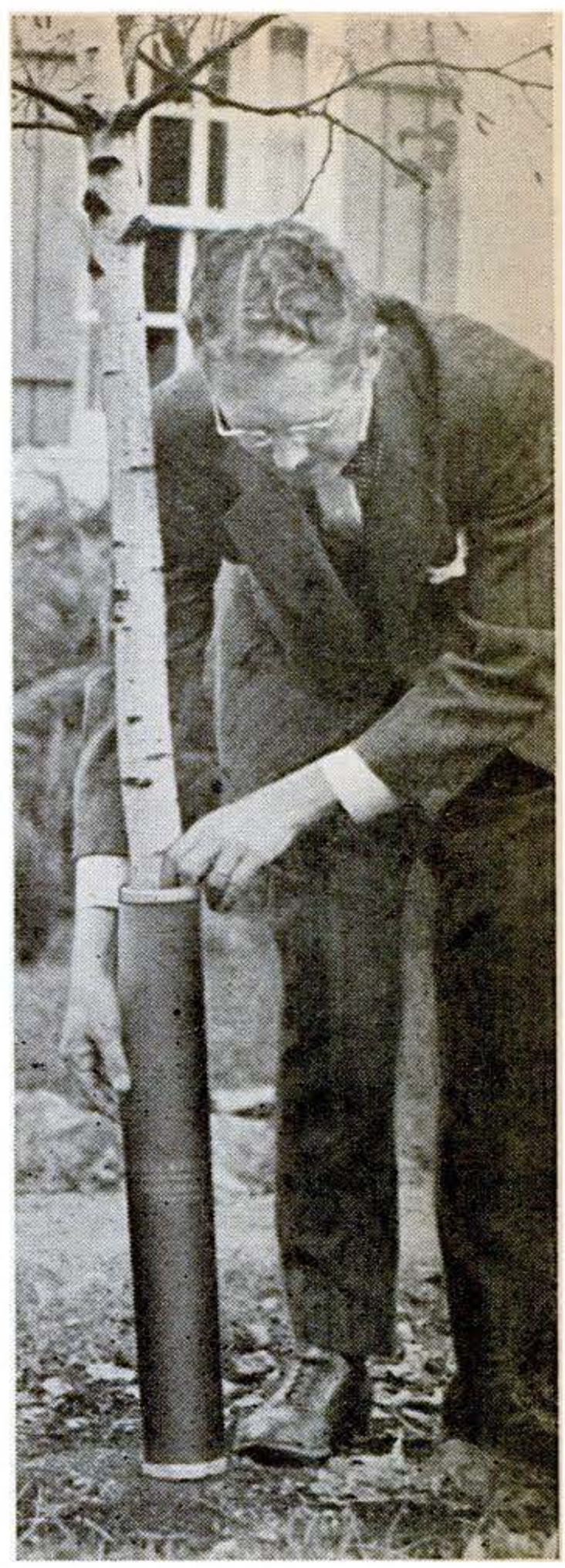
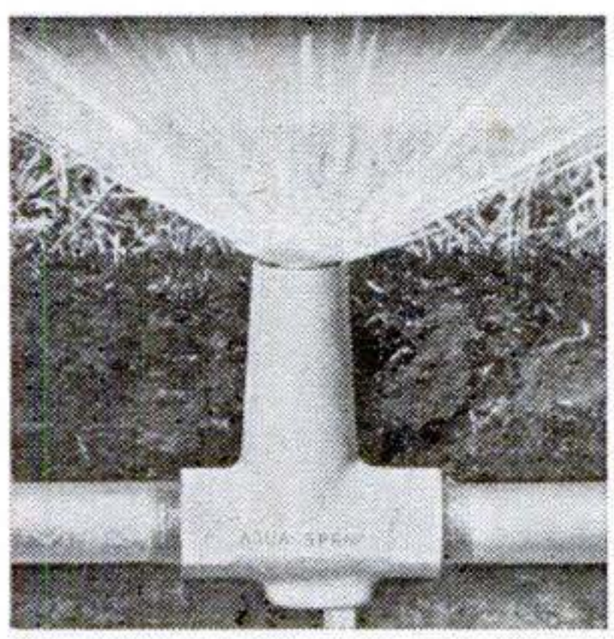
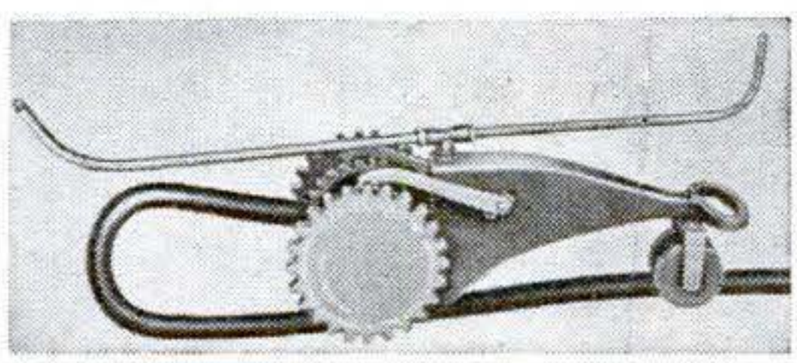


TONGUE-AND-GROOVE EDGES and an asphalted-gypsum core make a new, quickly installed sheathing both windproof and waterproof. The sheathing, a product of the United States Gypsum Company, requires no sawing to fit to studs. It is nailed in place, scored at the fit, and snapped off smooth. According to the maker's tests, it adds structural strength and resists fire.

PROTECTION FOR TREES against such troublesome bark eaters as rabbits, field mice, and moles is provided by the guard shown at right. Strong springs incorporated in the material curl it around a tree without tying or fastening. As the tree grows, the guard automatically expands and will cover a trunk up to 3″ diameter. Laminite Products, of Canton, Ohio, makes it.







Pipes for the flush sprinkler at left are installed in a 3″ trench. The whirling sprinkler above walks along the hose. At right, a nozzle that pops up when watering.

THREE NEW LAWN SPRINKLERS have recently been put on the market. Those shown above at left and right are for permanent underground piping, while that at center travels along the line of the hose as it waters.

The sprinkler at left is made by the Aqua-Spray Lawn Sprinkler Co., of Detroit, and features a self-draining nozzle head. With piping 3″ under the sod, its nozzle is flush and hidden. A disappearing act is done by the nozzle at right, a product of the Burklyn Company, of Los Angeles. Normally the nozzle is flush, but when water is turned on, it pops above the grass. The sprinkler that walks is called Trav-el-awn, and is made by the Stansen Corporation, of Chicago. It operates on hydraulic power and can be adjusted to shut off when watering is completed.

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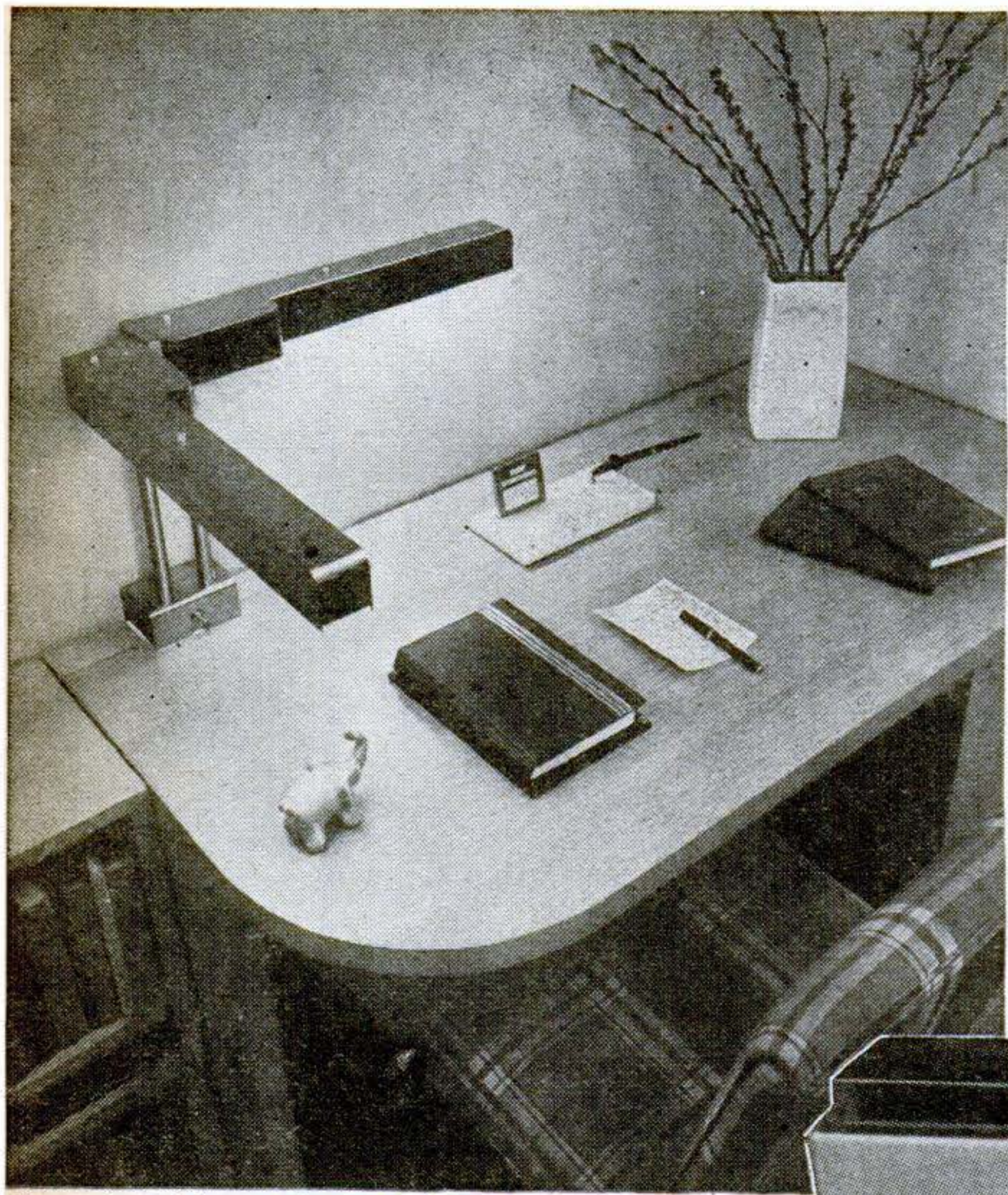
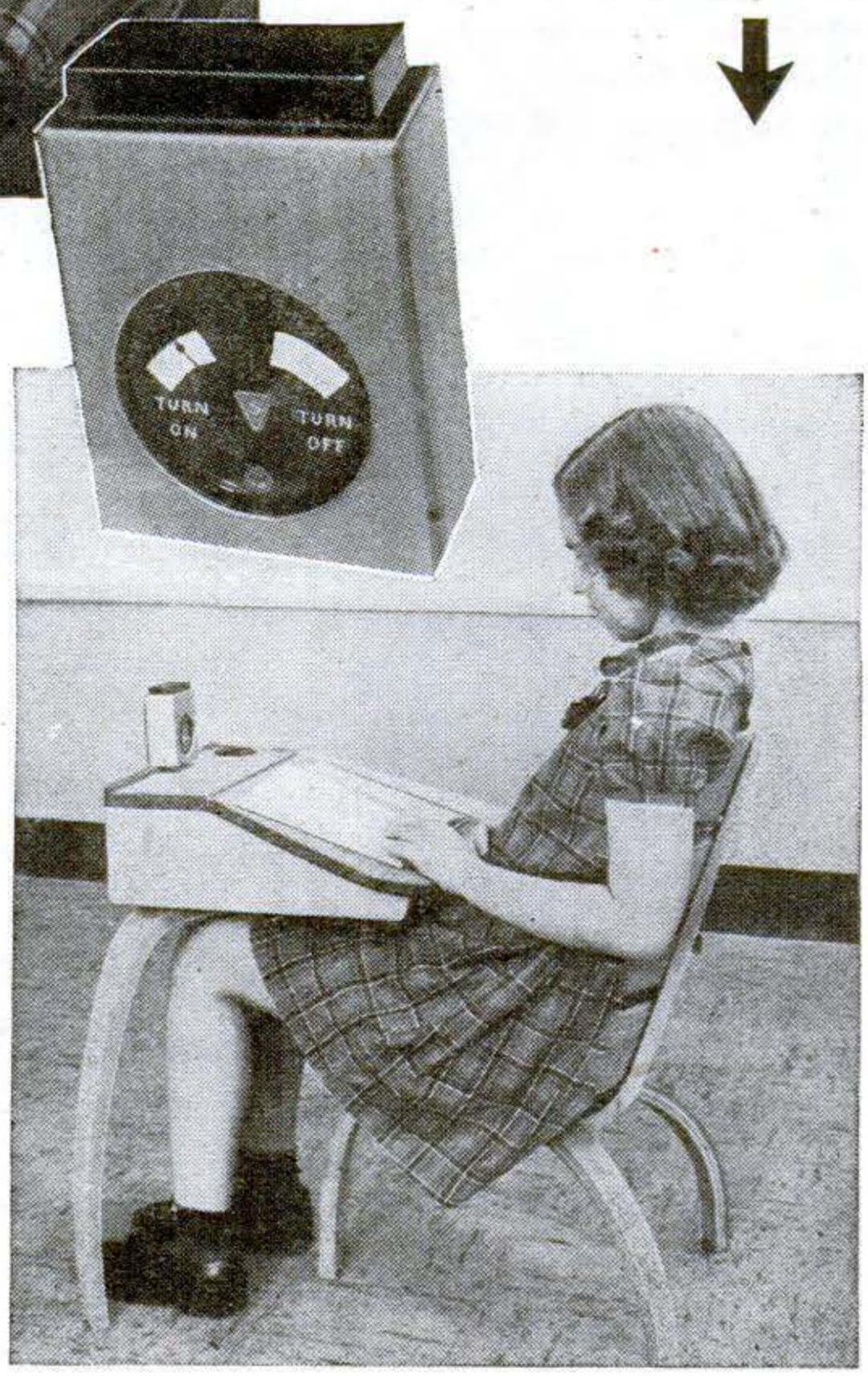
BRIGHT NOTES in HOME LIGHTING



Right-handed or left-handed, the writer receives correct illumination with this desk lamp. Each lamp arm holds a fluorescent tube and can be swung through a 90-deg. arc to permit placement at the side best suiting the user.

A student "light monitor," using this new meter, keeps check on illumination in a Salem, Mass., model schoolroom. The meter needle, actuated by a photoelectric cell, tells the monitor when lights should be switched on or off.

Photos from Sylvania Electric Products Inc.



HARMONIOUS blending of fluorescent and incandescent illumination with the decorative scheme of the surroundings is emphasized by lighting stylists in new designs for the postwar home. Model rooms show fluorescent fixtures, which, while retaining their utility and providing even, glareless light in sufficient quantity, present a pleasing appearance either lighted or unlighted. With the addition of incandescent table and floor lamps which can be moved to any desired location, the illumination is flexible enough to meet all needs.

The model rooms demonstrate the use of hidden fluorescent tubes to furnish the soft general illumination preferred as a glareless background to auxiliary lighting or, alone, to brighten corners for conversation and visiting. These fixtures, concealed in book shelves, wall brackets, and window valances, may high-light decorative accessories, pictures, bric-a-brac, and even plants. Because fluorescent lamps give off very little

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Long fluorescent tubes close to the ceiling over kitchen counters give ample light without shadows.

Concealed in a corner bracket, a lamp helps light the table while providing a decorative note.

heat in operation, most plants can safely be grown close to them.

Illuminating engineers have also turned their attention to the problems of lighting schoolrooms, suggesting new ways of eliminating sky glare from large windows and of regulating overhead fixtures, as shown at left below and on the facing page.

Sky glare from big schoolroom windows is eliminated by fixed vertical louvers which tilt for cleaning.

Typical of new designs, this studio room has hidden fluorescent tubes, ceiling fixture, and table lamp.

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One-Evening Projects in Crystal Plastic

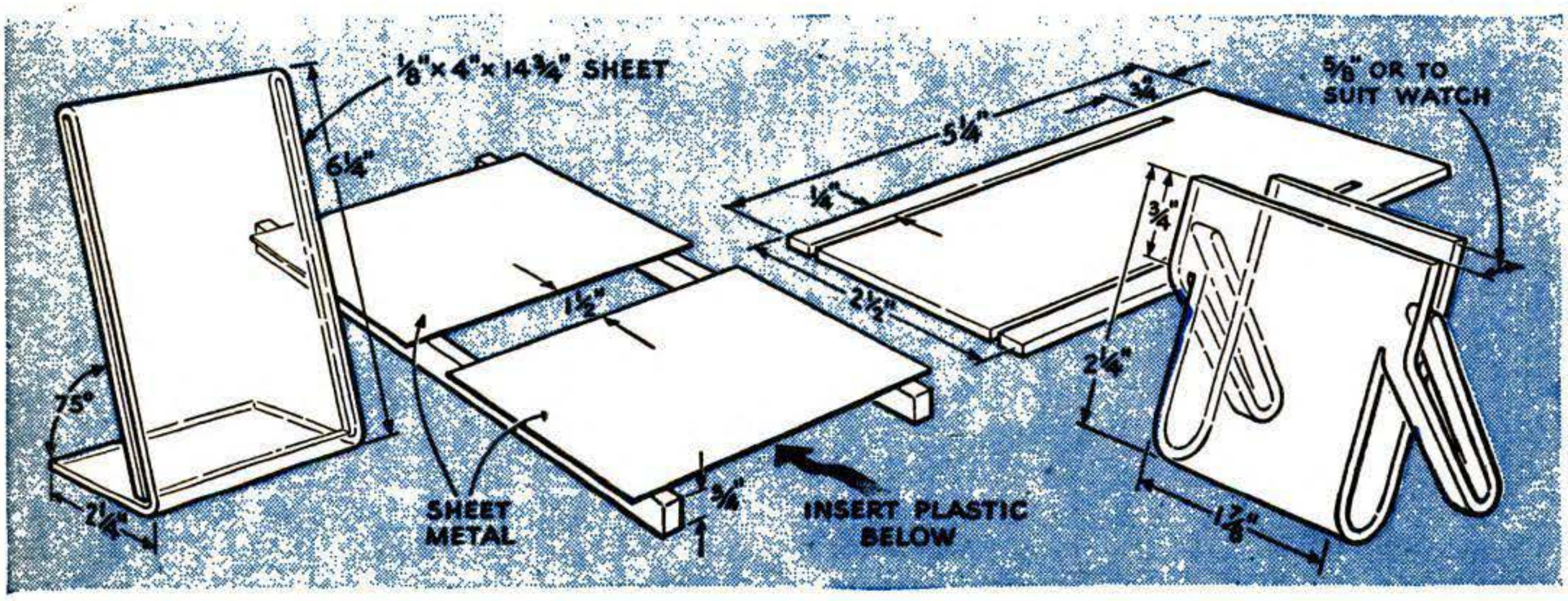
By FRANK SHORE

BESIDES sprucing up a desk, these two plastic items will give protection to a favorite photograph and enable you to use a pocket watch as an attractive standing timepiece. Both are made of ⅛″ clear plastic.

For the frame, it is best to heat the plastic only where it is to be bent so as to keep the rest flat. This can be accomplished with a 250-watt heat lamp and the jig below. First sand the edges of a ⅛″ by 4″ by 14¾″ sheet of plastic, bevel them slightly, and round off the corners a bit. Then make pencil marks on the edges 2¼″ from one end and 6¼″ from the other.

Rest the plastic on a smooth surface and arrange the jig over it so that the slot between the two pieces of metal comes at the 2¼″ mark. Support the heating lamp about 7″ above the plastic. When it is soft at this point, remove it with gloved hands and bend it, using a flat piece of metal as a guide. The bend at the 6¼″ mark may be made in the same way and can be flattened by reheating and pressing between smooth metal. Back up the picture with a piece of cardboard and slip it into the holder sideways, using cardboard of sufficient thickness to make a snug fit.

For the watch holder, first cut in along each side, leaving ¼″ strips. Sand the edges, heat the whole piece until soft, and bend double with gloved hands, preferably over a wooden form having a rounded edge. Then bend the props at an angle as shown.



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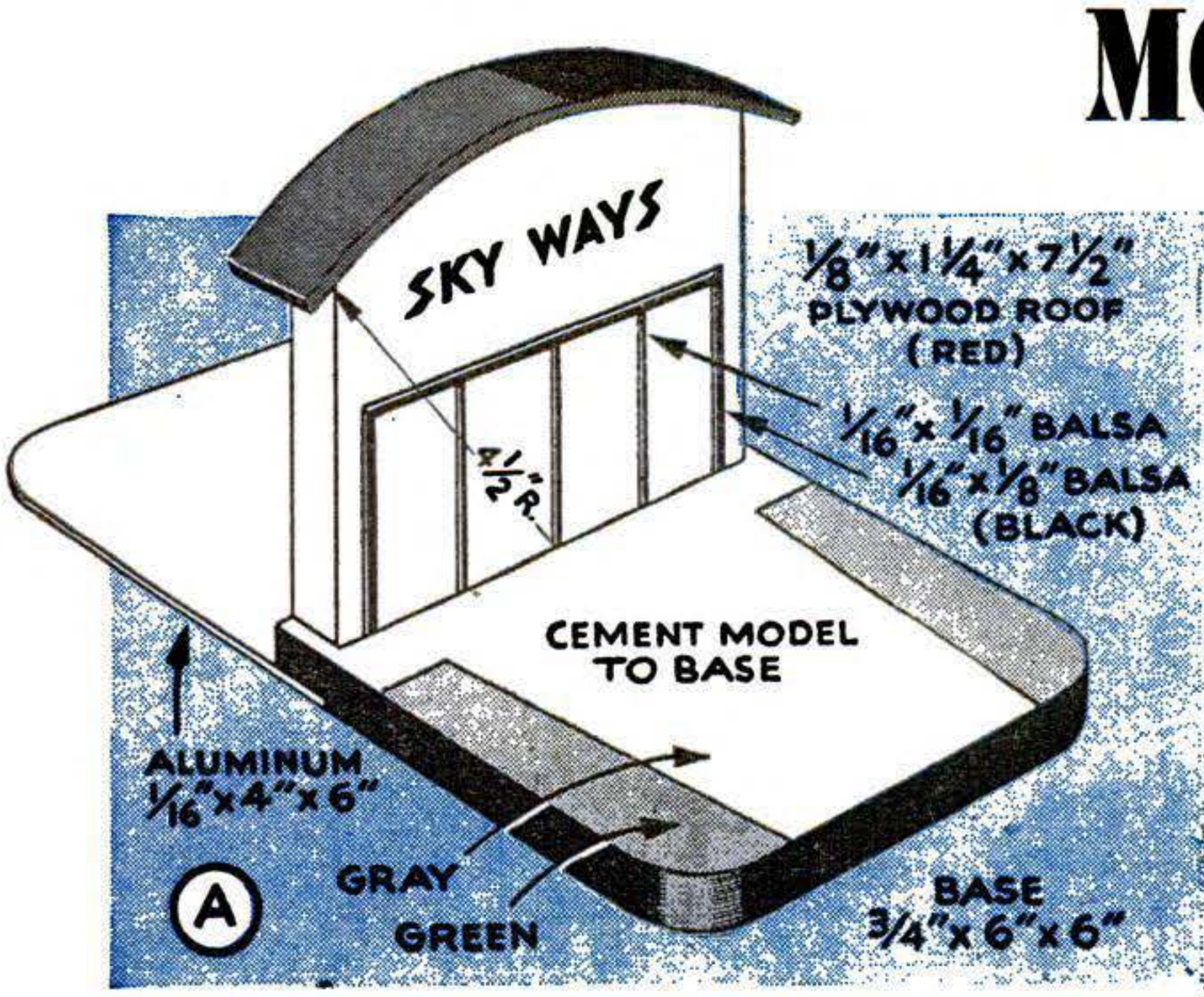
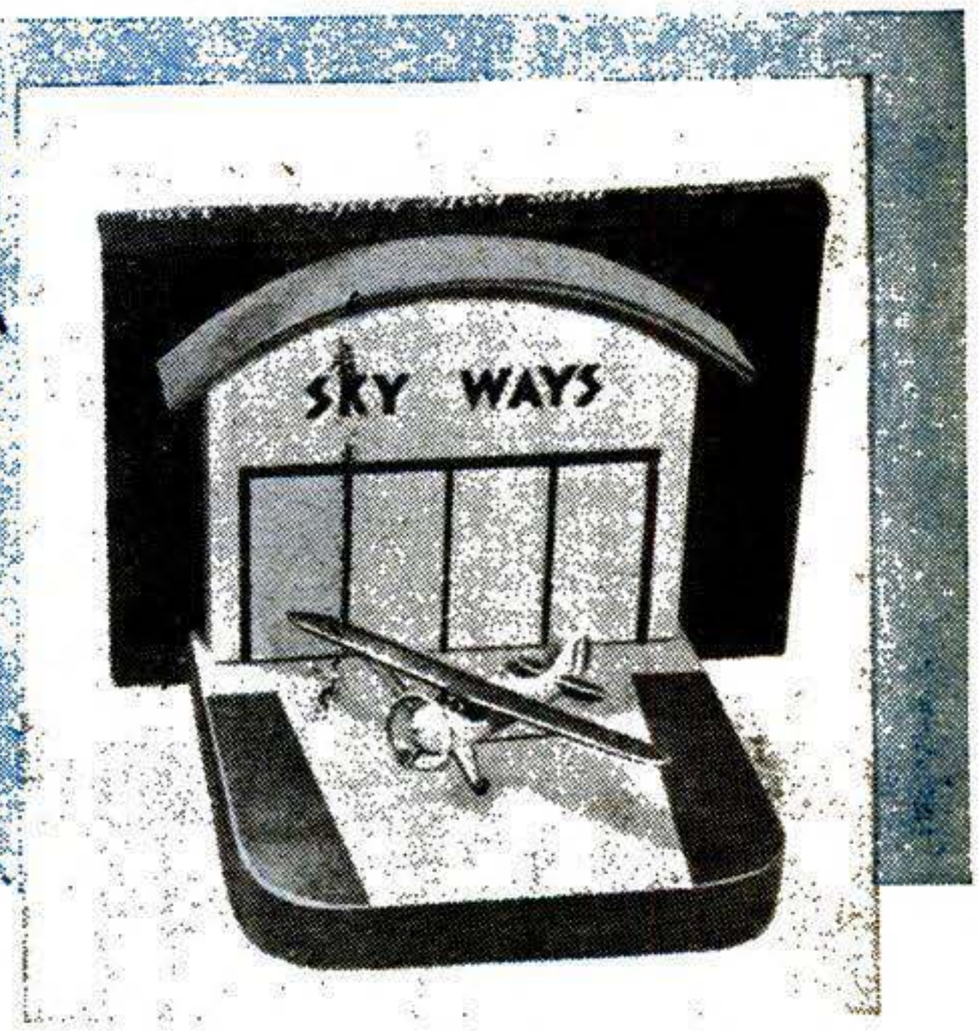
DISPLAY MOUNTS for your MODEL PLANES





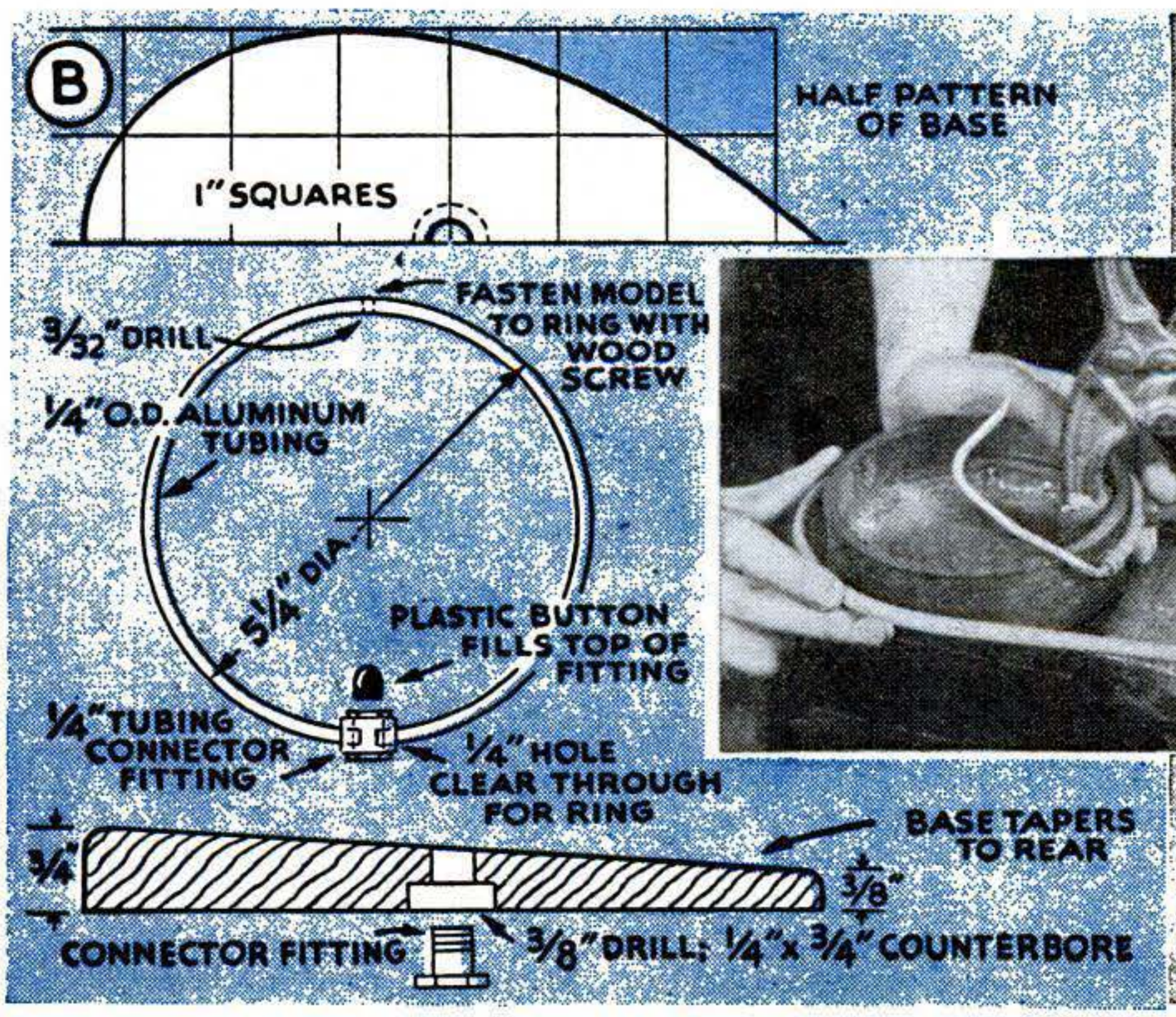
By DELMAR W. OLSON

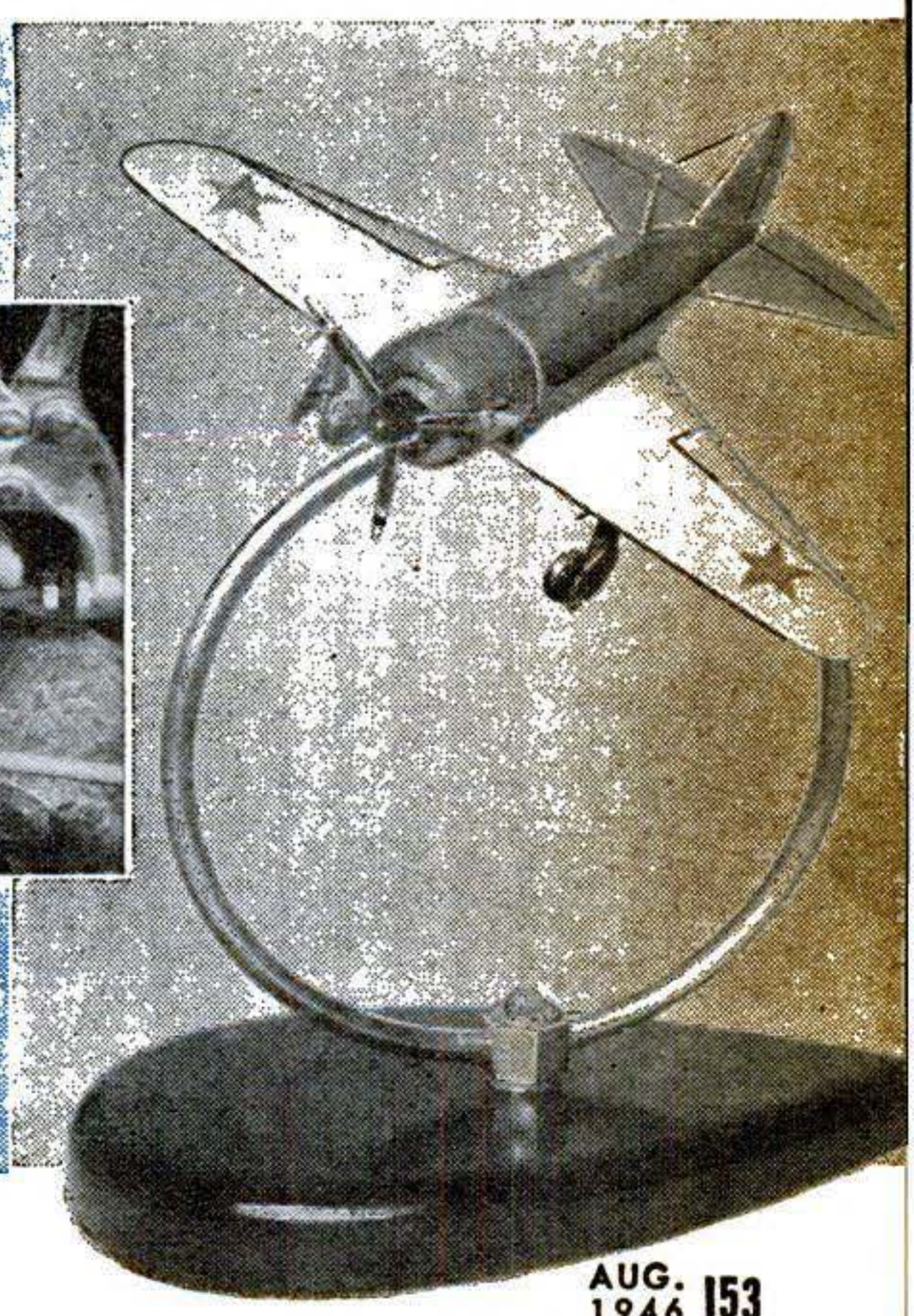
DO YOU "ground" your scale model planes on a shelf after they've been finished and admired by a few friends? If so, take a second look at them, for they make excellent decorations when mounted.

Small models are displayed to good advantage on the book ends shown at *A* and in the photo above. A shallow rabbet in the base receives the aluminum sheet on which books rest, and the upright, which is ¾" by 4½" by 5½", is attached with glue and countersunk screws.

Sand the wood parts, apply a sealer coat, sand again, and give each piece the final coat of paint before assembling. The doors are black-painted balsa strips cemented fast. Cut and glue on black-paper letters.

A polished aluminum ring on a tapering tear-drop base makes an especially attractive mount. Hard maple or birch is prefer-





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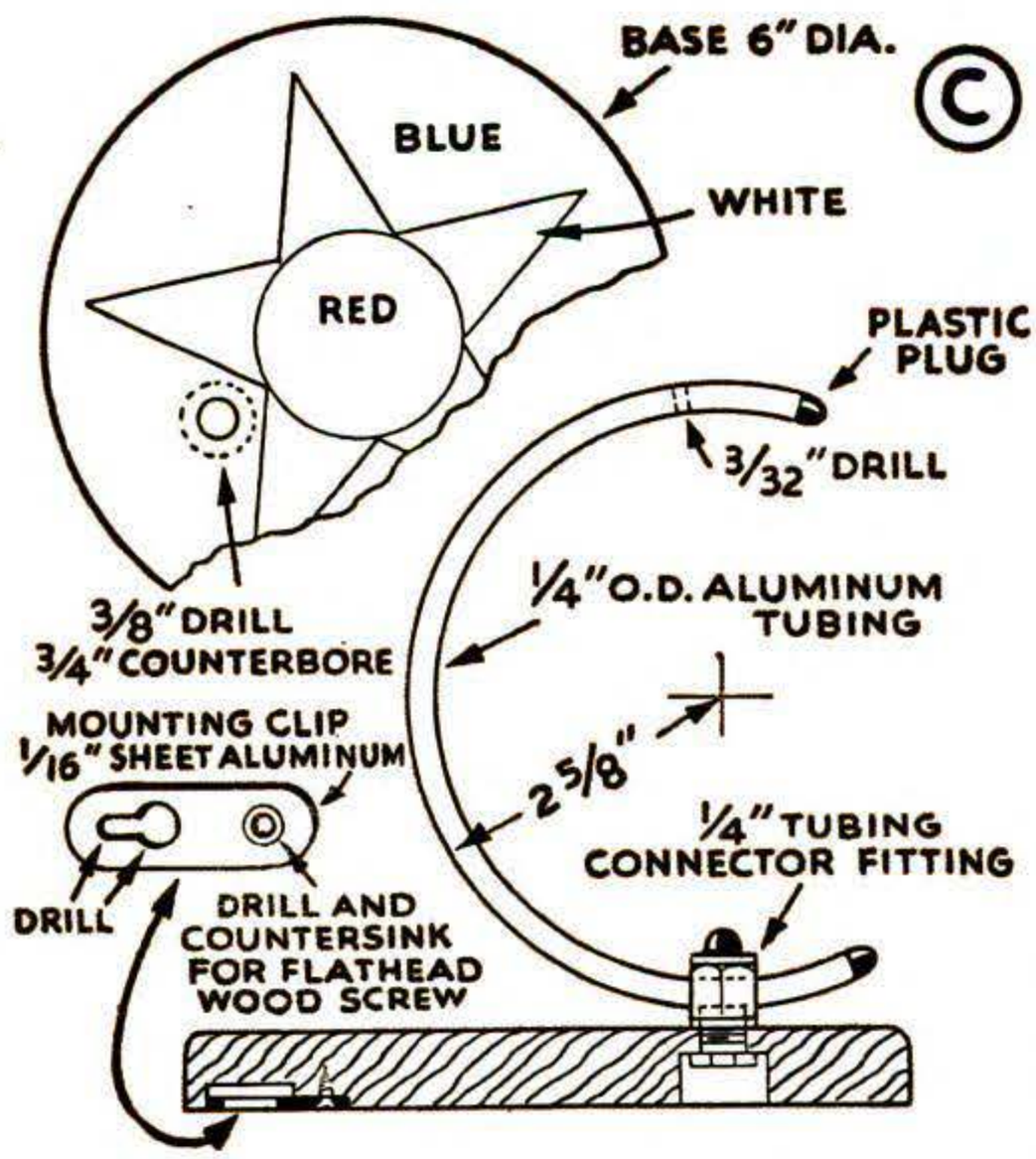
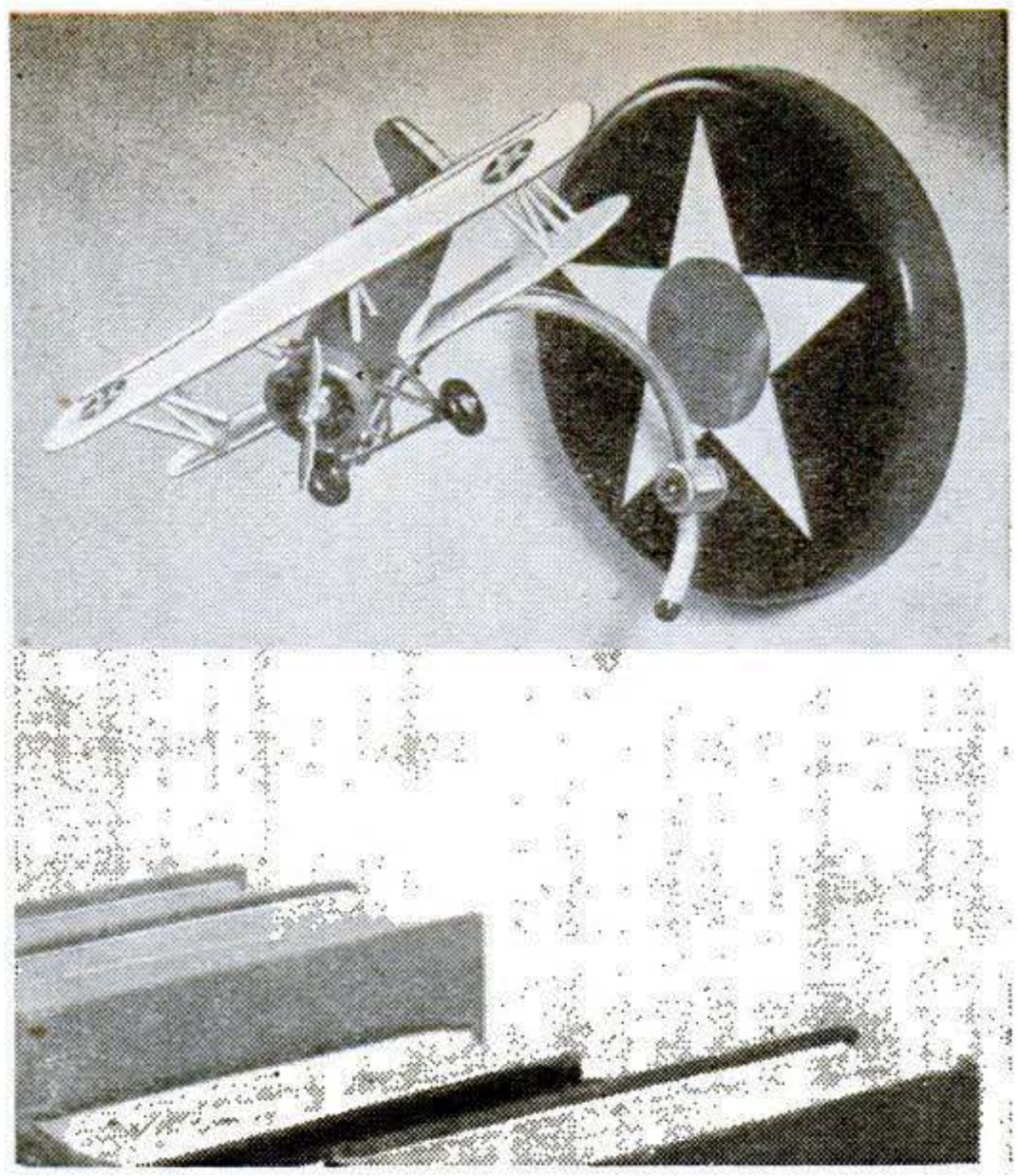




able for the base since a fine finish is desirable. Cut it to shape as in drawing *B*, round the edges, drill and counterbore for the connector fitting, and sand.

After applying an undercoat of lacquer sealer or thin shellac, sand the base again and follow with six or eight sprayed coats of black lacquer or airplane dope. Rub this down with a rubbing compound, then wax.

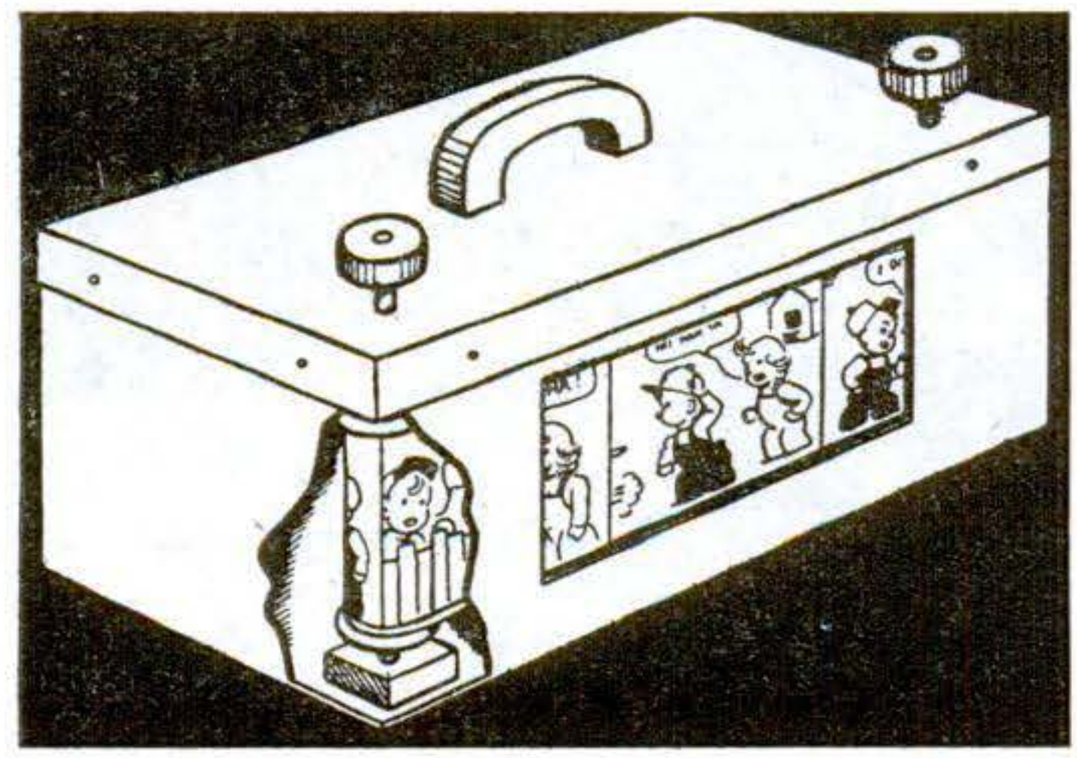
If aluminum is not available, copper or brass tubing may also be used. Insert wire solder into the tubing, bend it around a piece of pipe, and then pull out the solder. The ring support was made from a ¼" tubing connector fitting. With careful work, the lower fitting will serve both to hold the ring-support fitting tight and lock the ends of the ring. A plug for the fitting may be made by chucking a piece of plastic rod in a drill press, shaping with a file and sandpaper, and polishing.

The wall mount shown above was designed especially to display the Boeing biplane. On the base is the Air Corps insigne at the time this plane was in use.

Except that a half ring is used, construction *(C)* is similar to the preceding mount. After a sealer coat was sanded smooth, the base was sprayed with white lacquer. Then a star mask cut from paper was attached with rubber cement and the blue sprayed on. A circular hole next was cut in the star and the opening sprayed red. When the lacquer was dry, the mask was peeled off, and the surface was sanded lightly, polished, and waxed.

Shoe-Box "Movie" for Comics

MANY a youngster will find pleasure in this "movie" for showing especially treasured comic-strips. Cut a rectangular hole in one side of a shoe box, fit dowels tightly into two large spools, and mount the spools as indicated. Glue the comic-strip panels to a band of heavy paper, and tack each end to a spool. Wooden knobs pressed on the dowels will enable the youngster to operate the "movie" readily. They can be removed for mounting a new strip.—J. M. CONNOR.



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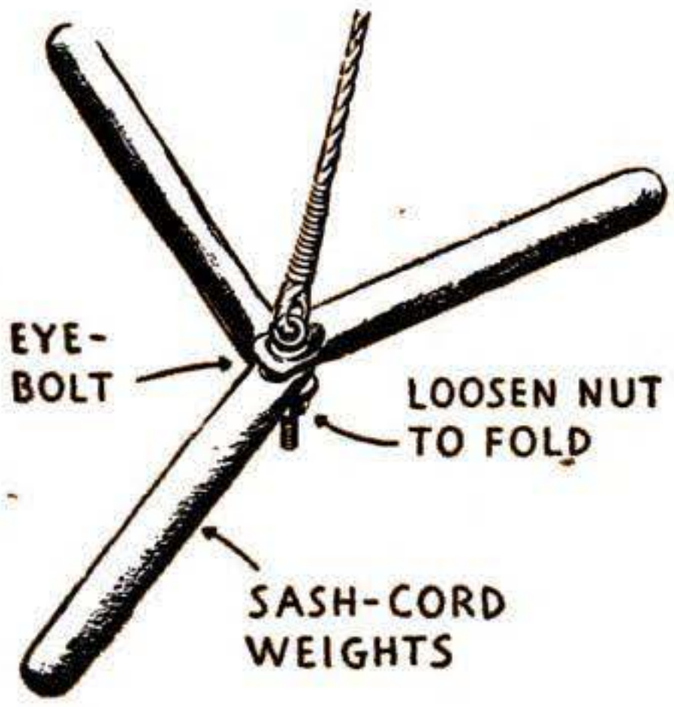
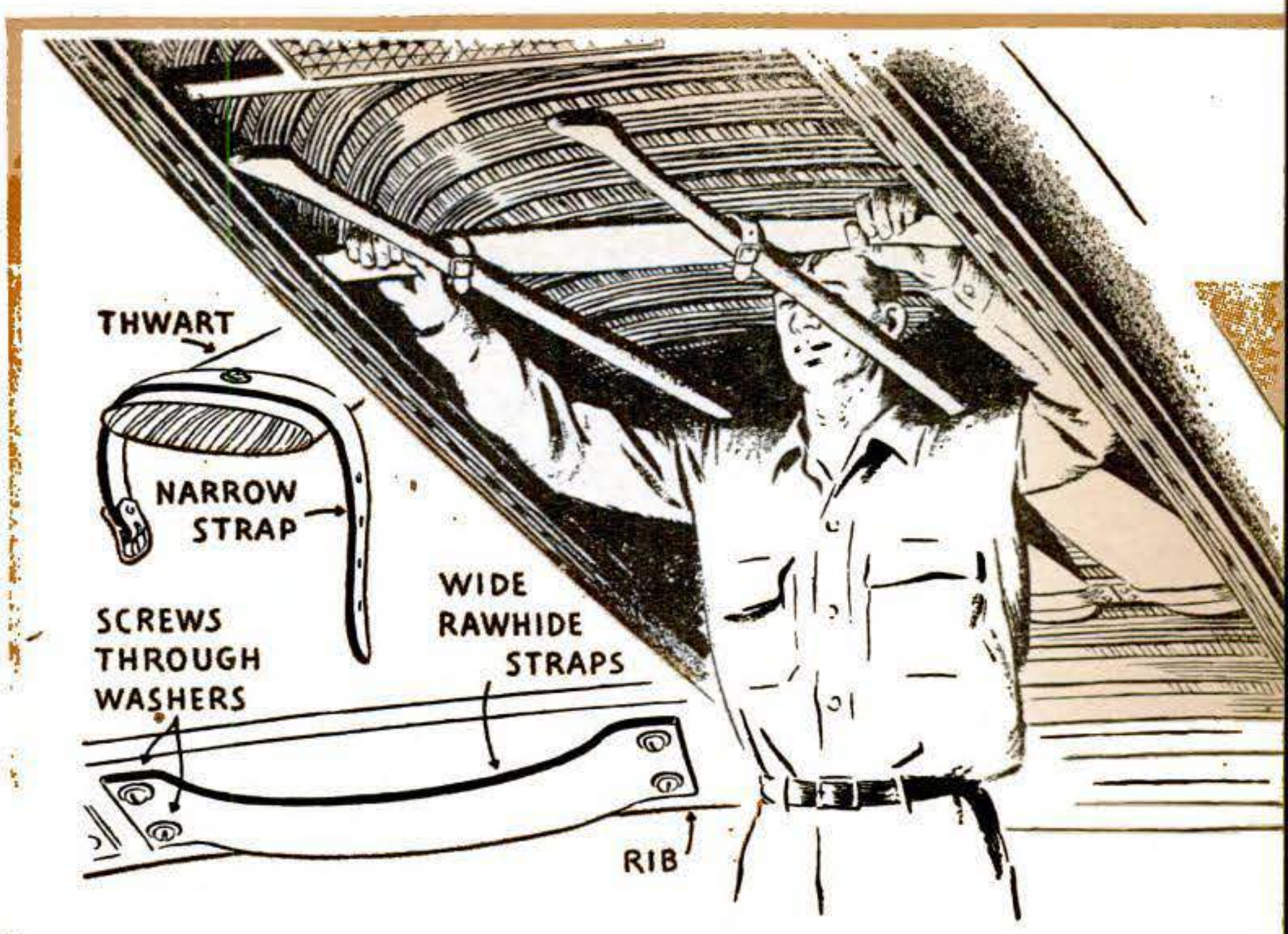
Sash-Weight Anchor

THREE sash weights are all you need for a useful folding anchor capable of holding small boats. Once the weights are arranged in the desired position, simply fasten them together tightly with an eyebolt through the holes found in the end of each.

Loosening the eyebolt will permit the anchor to be folded for convenient storage or transportation. The shape of the weights stops dragging under most conditions and makes the anchor easy to clean. Paint retards rust.—R. A. JENKINS.



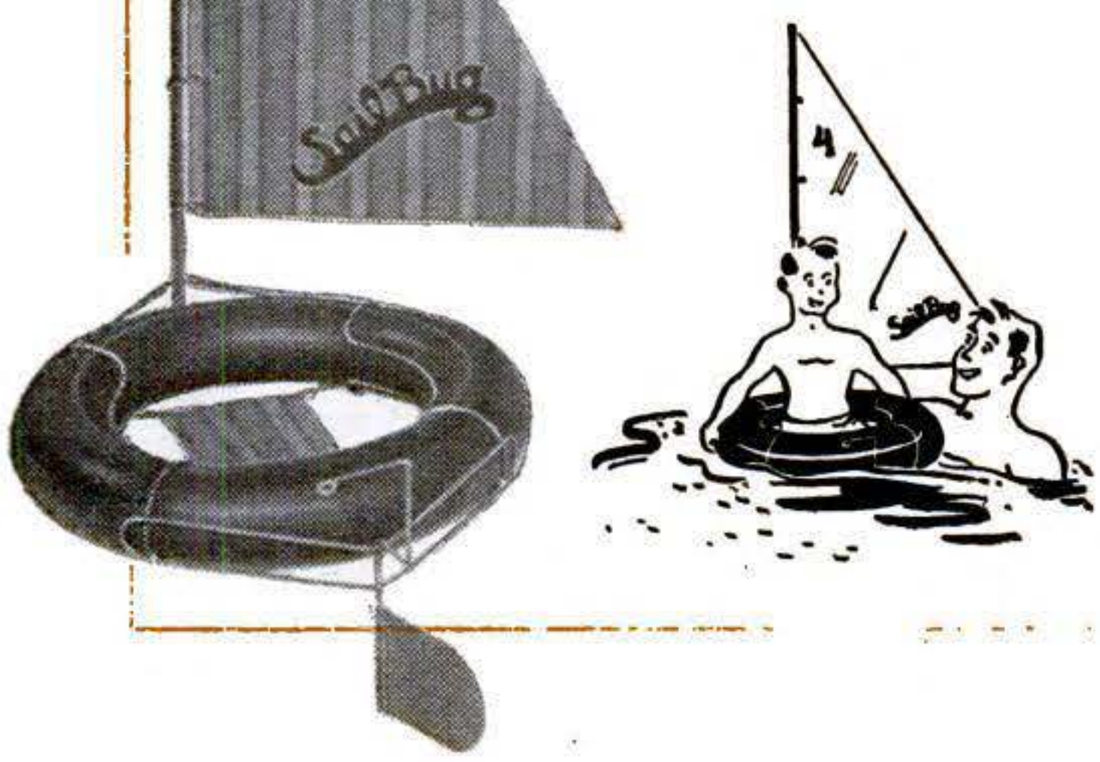


Canoe-Paddle Holders Ease Portaging

EVEN Indians would applaud this idea for simplifying the portaging of canoes. The straps illustrated, permanently fastened to a thwart, hold the paddles with blades spread correctly for the carrier's shoulders, and in the position of best balance. After testing to find a desirable location, insert roundhead screws to attach the two leather straps.—J. A. EMMETT.

Go Yachting in a Tire Tube

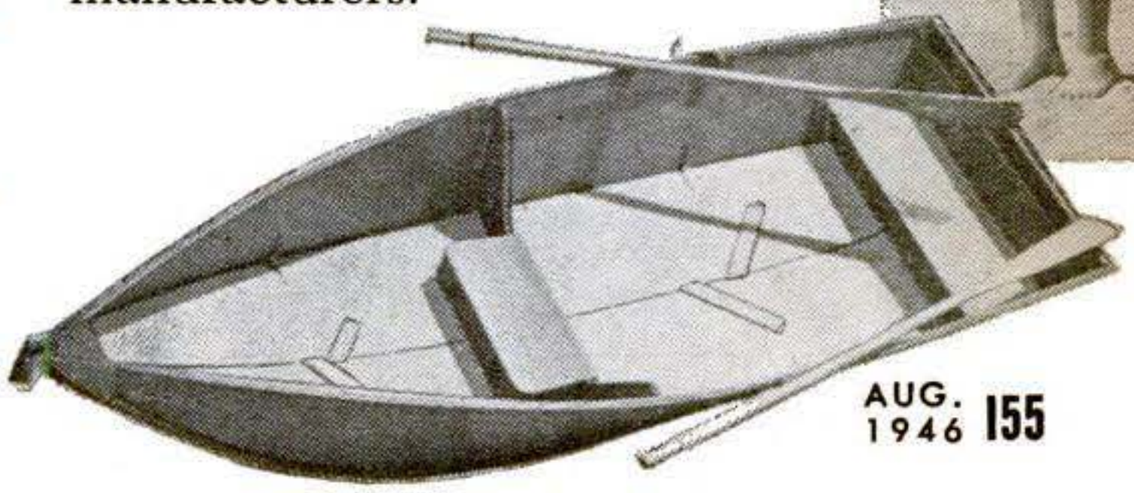
THE latest 1946 sailboat uses a tire tube for a hull. Consisting of a mast, sail, rudder, and wire frame, the "Sail Bug" is collapsible. Hampden Specialty Products, Inc., of Easthampton, Mass., makes it.



Plywood Boat Folds Up

WHAT to do with a boat during off seasons is no problem for owners of the Fold-Flat, a plywood folding boat. It closes to a pack 5½″ by 15″ by 10′ for transportation or storage. Open, the 80-lb. Fold Flat accommodates four, and is sturdy enough to mount a five hp. outboard motor.

With a hull of Douglas fir plywood, the boat's folding joints are protected by neoprene-impregnated fabric. Plyways, Inc., of Inglewood, Calif., are the manufacturers.



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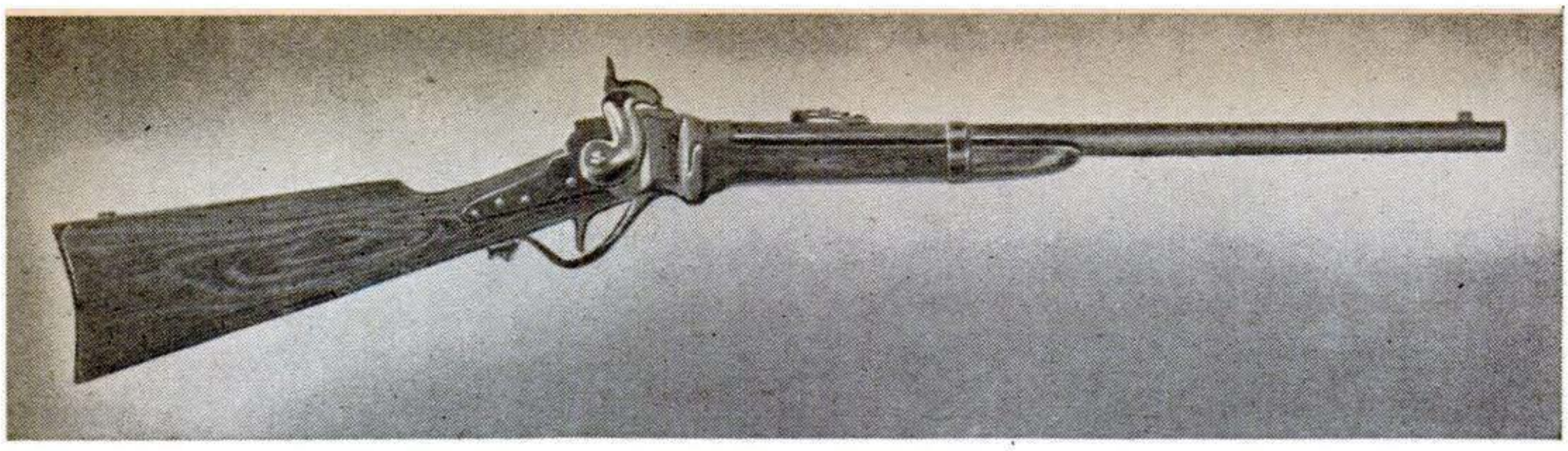
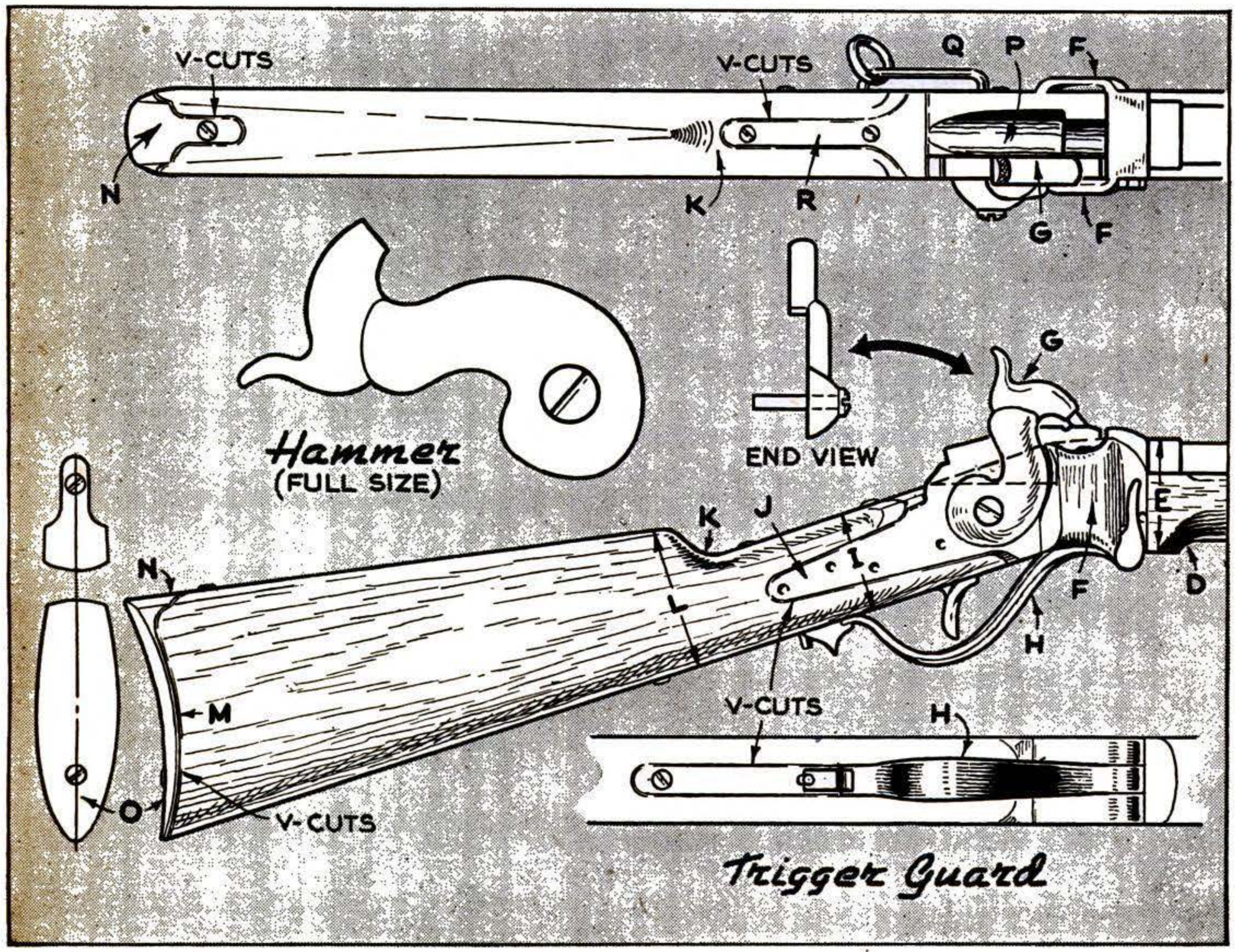


Wooden Model of a SHARPS BREECH LOADER

The Gun That Changed the Habits of American Riflemen

WARS and weapons have changed enormously in the last century, and the Sharps rifle has not only seen most of the change, but has played an important part in the process. Christian Sharps patented his first breech loader in 1848, then waited many years for recognition—which finally came from unexpected quarters.

Although Sharps made constant improvements and refinements on his original design, some influential military men scoffed at the gun as an unreliable toy, and clung to their old muzzle loaders. Civilian fighters, however—and there were many in those days—had no qualms about adopting a new weapon. The Kansas Territory, where many



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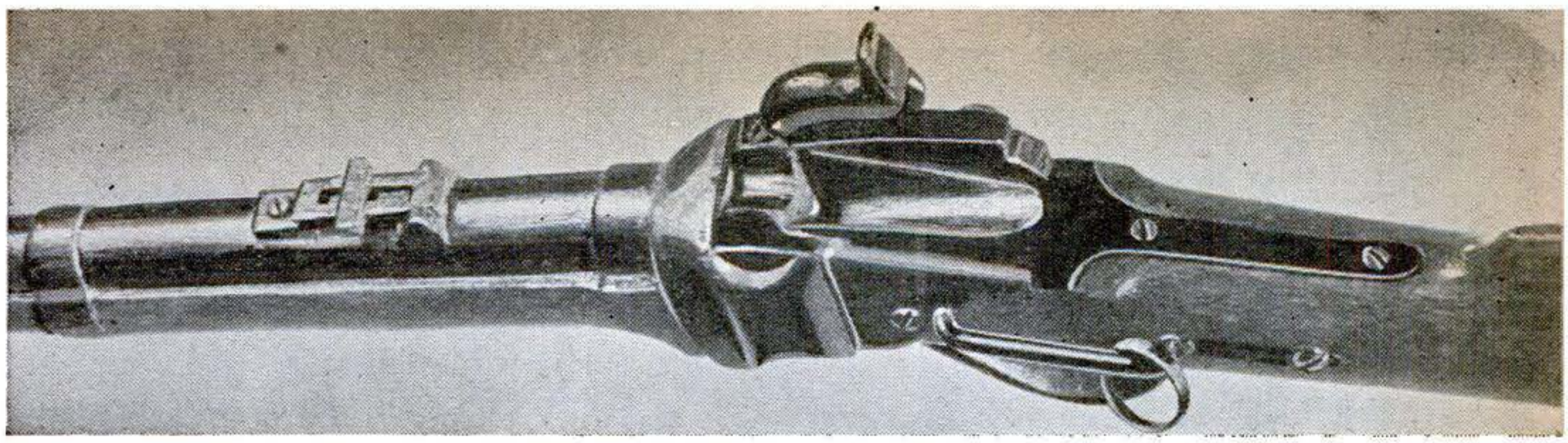
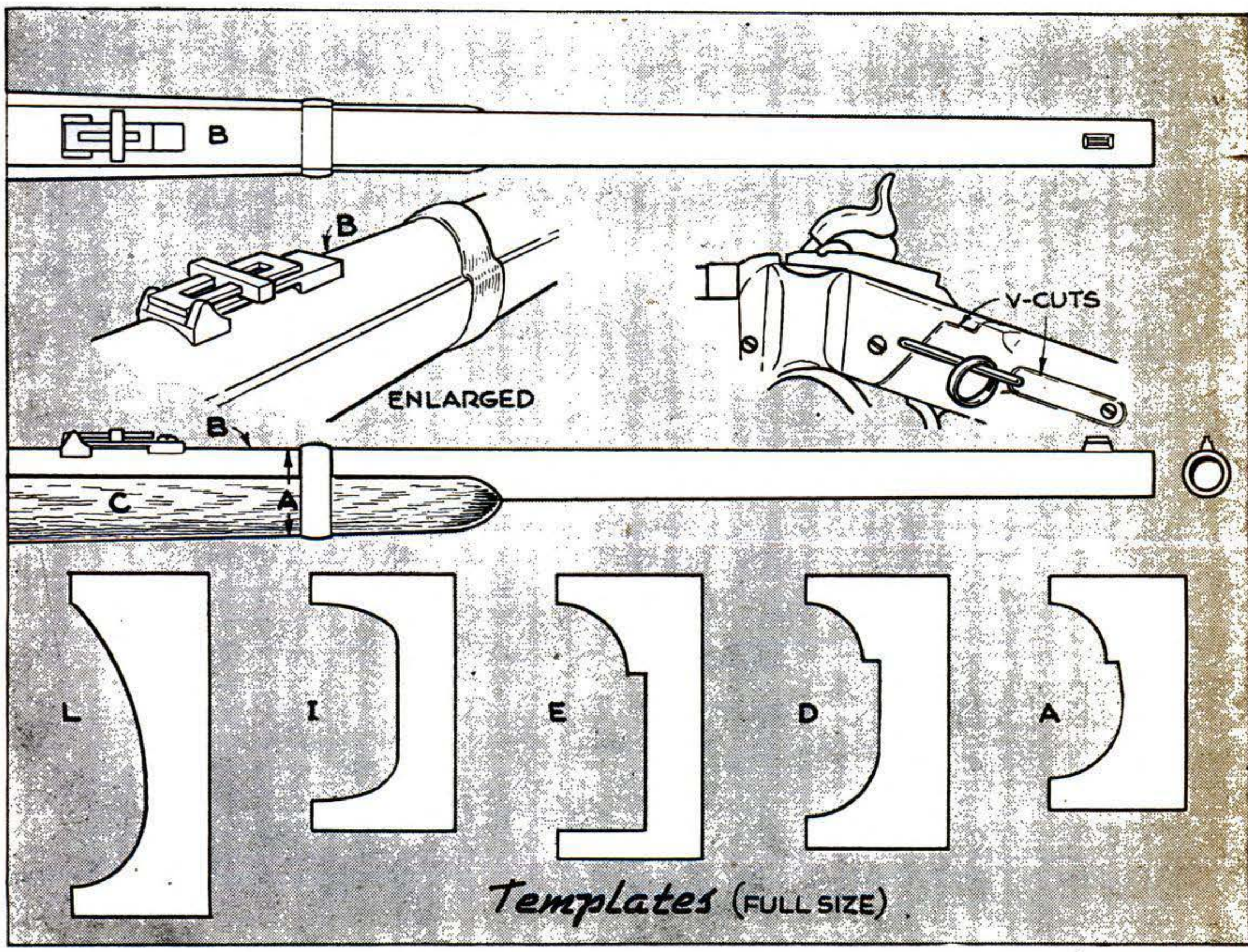


After alteration, the carbine's breechblock looked like this. Photo also shows the adjustable rear sight.

battles were fought before the Civil War, bristled with firearms; a sizable proportion bore the Sharps imprint. John Brown's men carried them in their Harper's Ferry raid; their popularity among the fighting abolitionists won them the nickname "Beecher's Bibles." The model shown here is of slightly later vintage. Thousands were made after 1859, and were used widely and effectively in the Civil War.

Following the war, in 1869, the government returned large quantities of these carbines to Sharps to be altered from percussion to cartridge fire. At that time the original of this half-size model was also relined to take .50/70-cal. government ammunition. In their new dress these guns traveled with the settlers of the West.

To make your model of this famous arm, enlarge the half-size drawings and trace them onto a ¾″ by 4″ by 19⅝″ piece of white pine or similar stock. The projecting plates F, and the hammer are cut separately to avoid using thicker wood. For the sling, Q, use 3/32″ wire and a ½″-diameter ring. Carving and finishing techniques are similar to those described in previous articles in this series—CARL G. ERICH.



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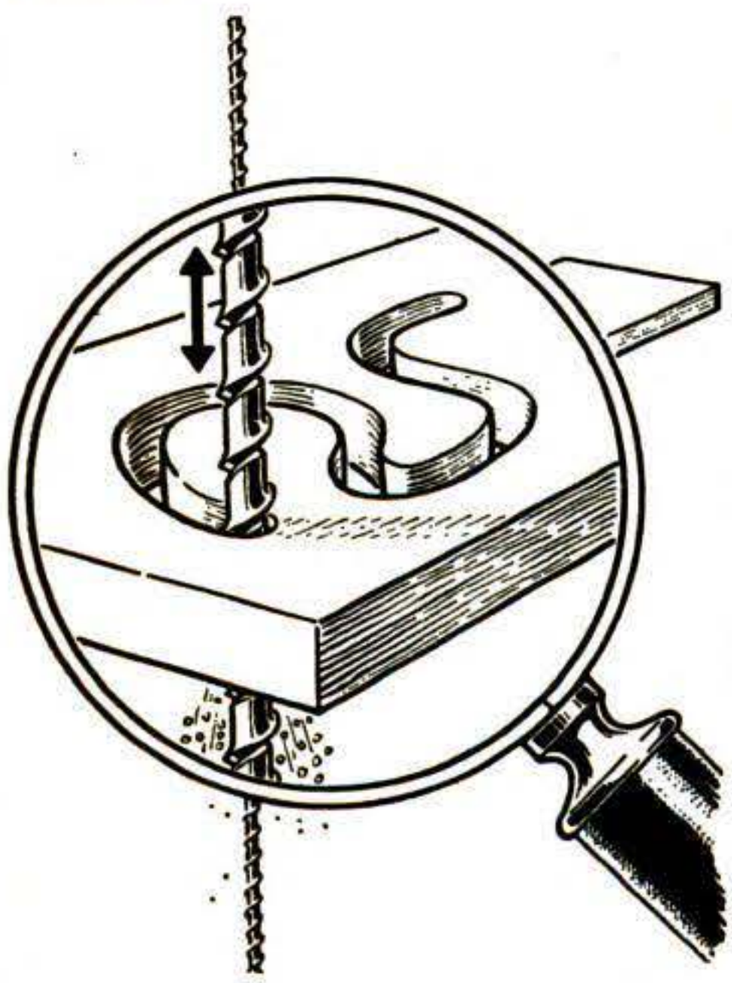
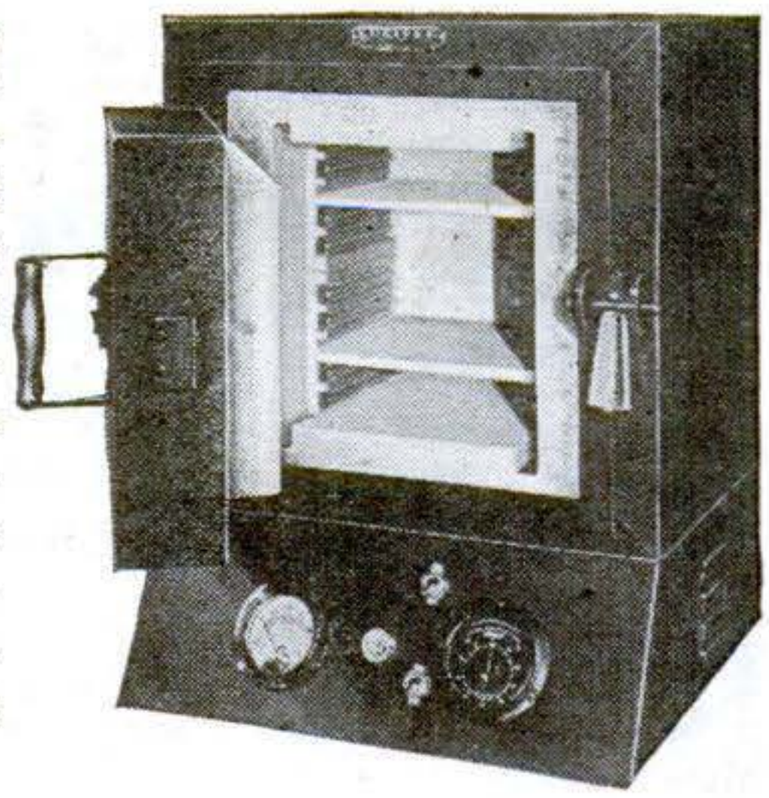
NEW TOOLS

FLANGES ARE OPENED quickly and easily for renewing gaskets with the aid of two flange jacks of a new design. The jacks are adjusted in position on opposite sides of the pipe flange, as shown in the photo at left. Pressure up to 15 tons is then applied by turning down on the screw. The flanges open evenly and the bolt holes remain in alignment. After the new gasket has been inserted, the flanges are closed again by reverse action on the pressure screws, and the bolts are reinserted in their holes and tightened. The manufacturer is T. G. Persson Company, of Bloomfield, N. J.

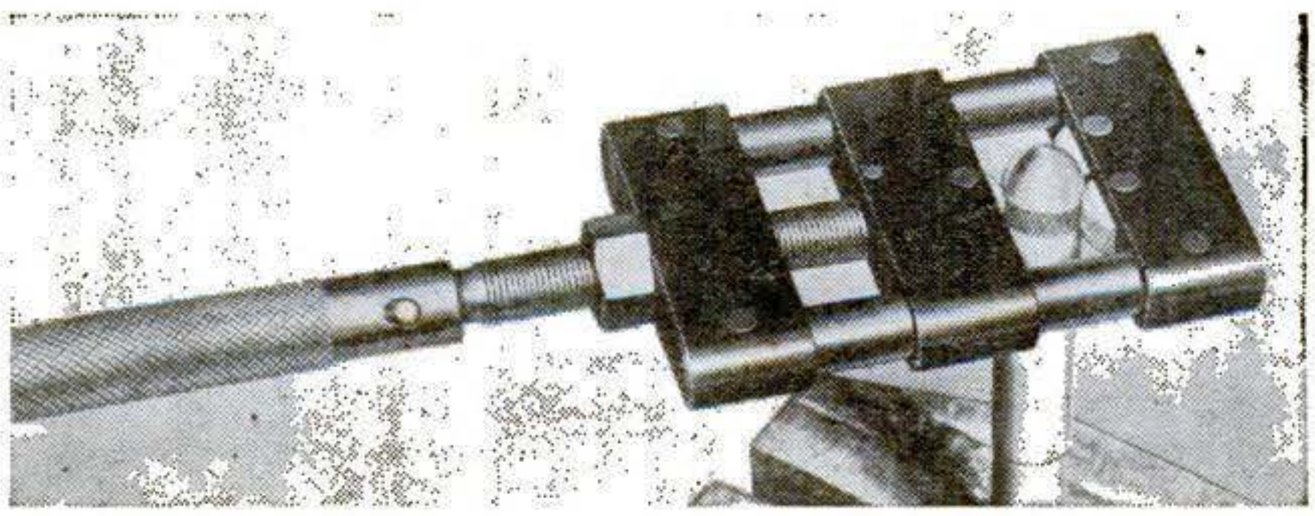
SPIRAL TEETH are a development on a blade for hand coping saws and power jigsaws. Called "Allways," the blade will cut in any direction, thus eliminating the necessity of turning a coping-saw frame and increasing accuracy in following a pattern on a jigsaw. It will cut wood, light metals, and plastic, and is designed to fit standard frames. The Tyler Mfg. Co., of Santa Monica, Calif., makes it.



HEAT OF 1,500 DEG. F. in 45 minutes is reported possible with the heat-treating furnace shown at right, the newest of the Lucifer Furnace line manufactured in Philadelphia. Automatic control maintains temperature at any point up to 2,000 deg. F. The furnace is available for either 115- or 230-volt A.C. operation.



KNURLING BY HAND as well as in the lathe or drill press is done with the tool shown below. Three knurling wheels exert uniform pressure on three sides of the work so that even soft stock that would bend easily can be knurled. The wheels can be adjusted to take work ranging from ⅛″ to 1″ in diameter. Pressure is kept constant by a screw and lock nut. The Weaver Corporation, of San Diego, Calif., is the maker.



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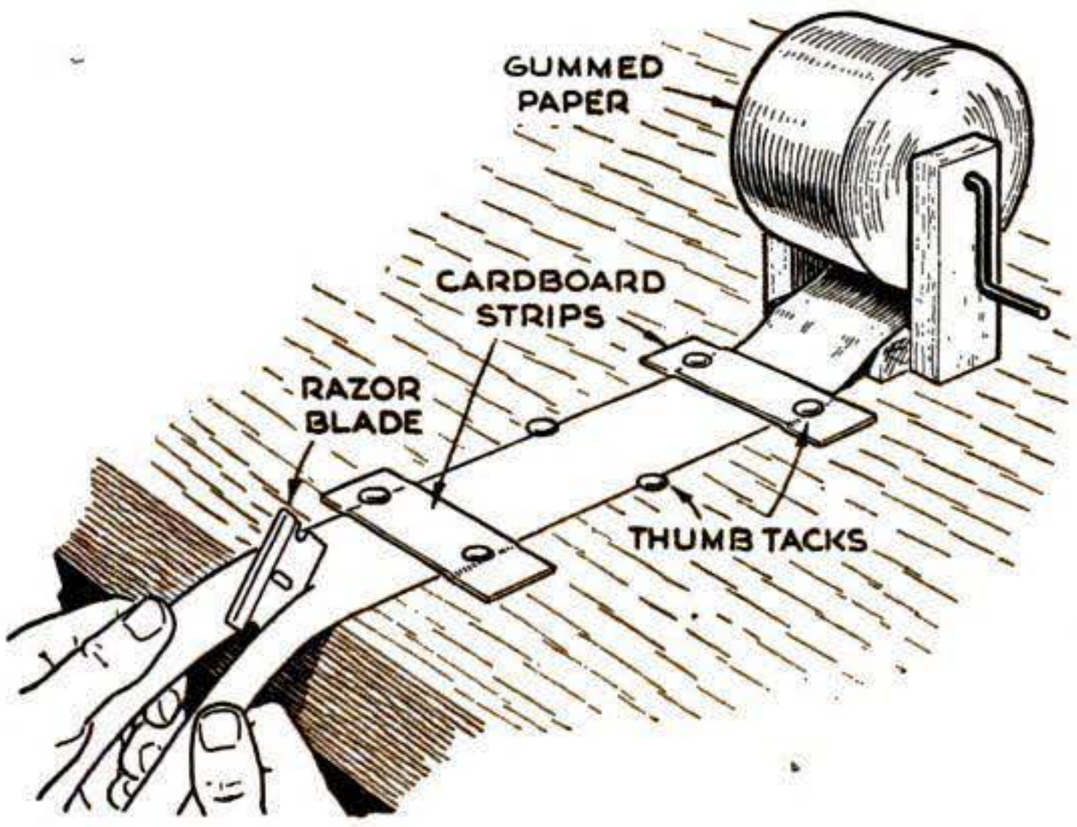
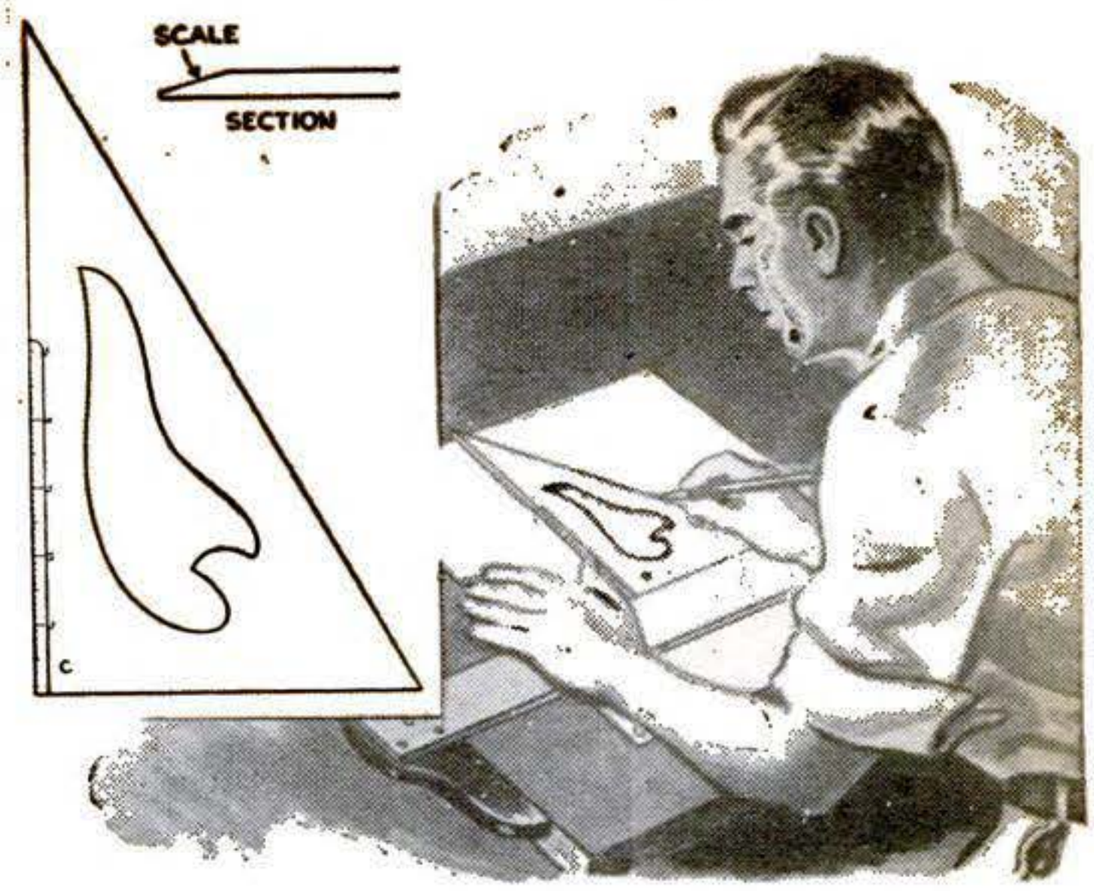
Blade Slits Paper Accurately

GUMMED tape, paper rolls, and the like can be slit readily with a razor blade and a setup like that shown below. Wide rolls are placed on a rough rack and guided through strips of heavy cardboard and pairs of thumbtacks. The paper is pulled against a blade pushed firmly into the edge of the bench, and then rewound by crank. A similar setup can be arranged for flat stock, and more than one blade may be used for simultaneous cuts.—G. E. HARRINGTON.





Triangle Has Curve and Scale

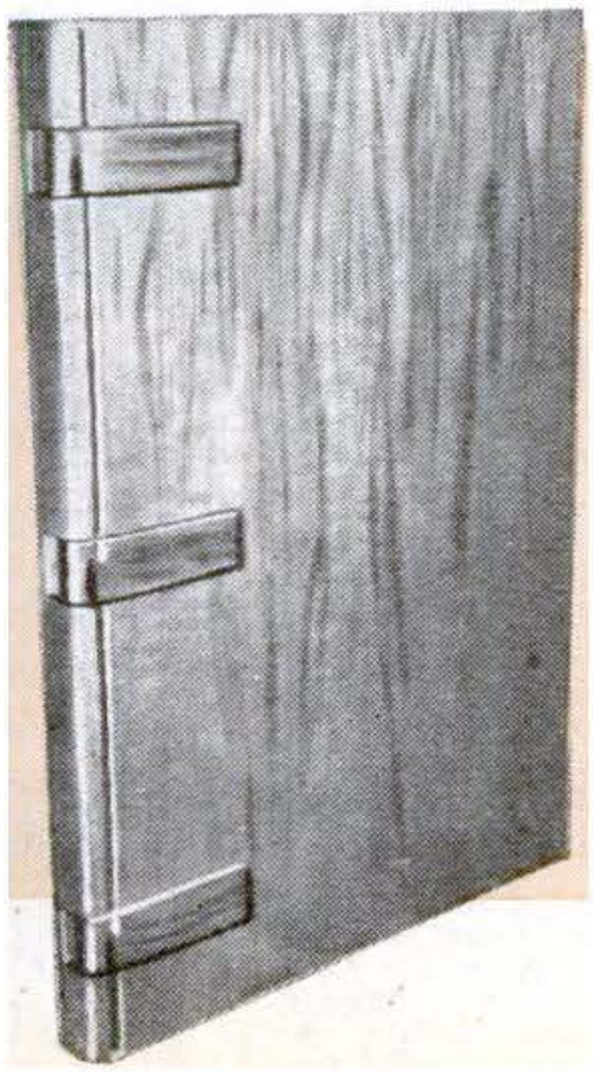
SQUARE two edges of 1/16" plastic sheet and lay out the 30- and 60-deg. angles with a protractor; then score deeply along a metal straightedge, break, sand lightly, and polish. Lay out the desired curves, drill closely spaced holes inside them, break out, and finish with a sharp knife, scraper, and sandpaper. Bevel and sand for the scale, mark the graduations, fill with India ink, and wipe.—H. A. THOMAS.

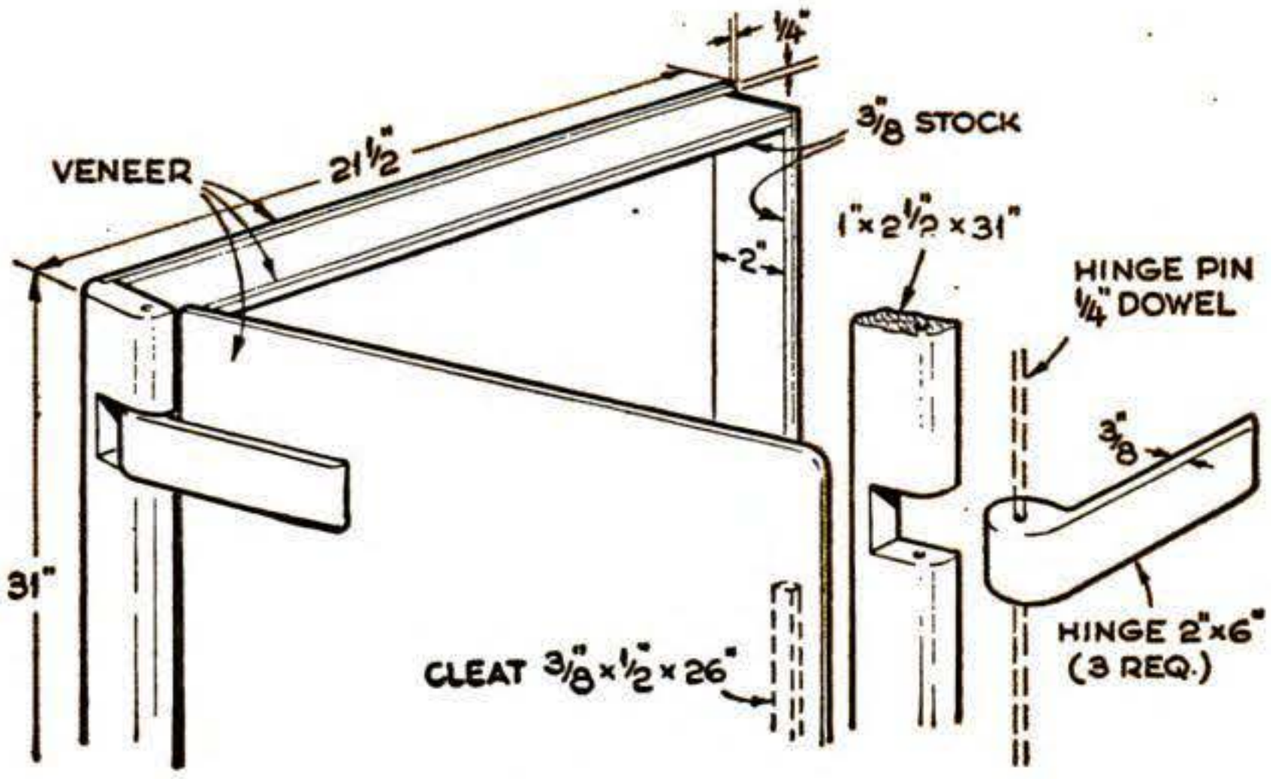
Walnut Portfolio Holds Blueprints, Salon Photos, and Drawings

BESIDES providing a protective cover for blueprints, large salon photographs, etchings, and drawings, the case shown below is a handsome portfolio. It was made of walnut-veneered plywood and solid walnut. The interior is 2" deep by 19⅝" by 29¼".

Make the lid and back from ¼" veneered plywood and cut three hinges [illegible] by 2" by 6" blocks of solid walnut. Three edges may be stock faced with veneer or waste strips of the veneered plywood. The hinged edge is solid walnut. Hardwood dowels serve as hinge pins at top and bottom, and the center hinge is a dummy.

Sand and rub with fine steel wool. Finish with equal parts of boiled or raw linseed oil and turpentine applied hot from a double boiler. Rub vigorously after it has dried 45 minutes. Repeat four to eight times, and wax.—JACK and JAN HOLMES.





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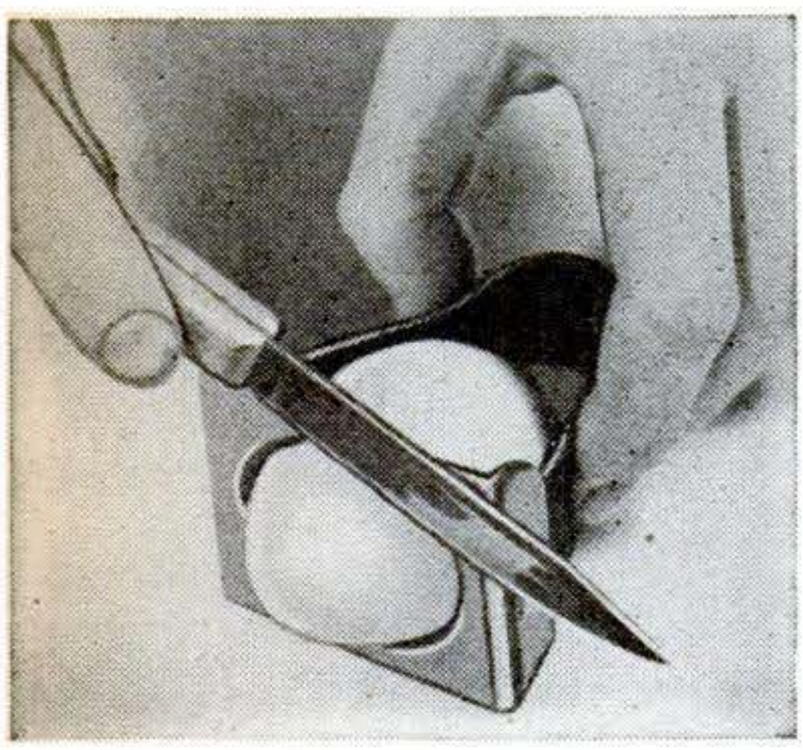
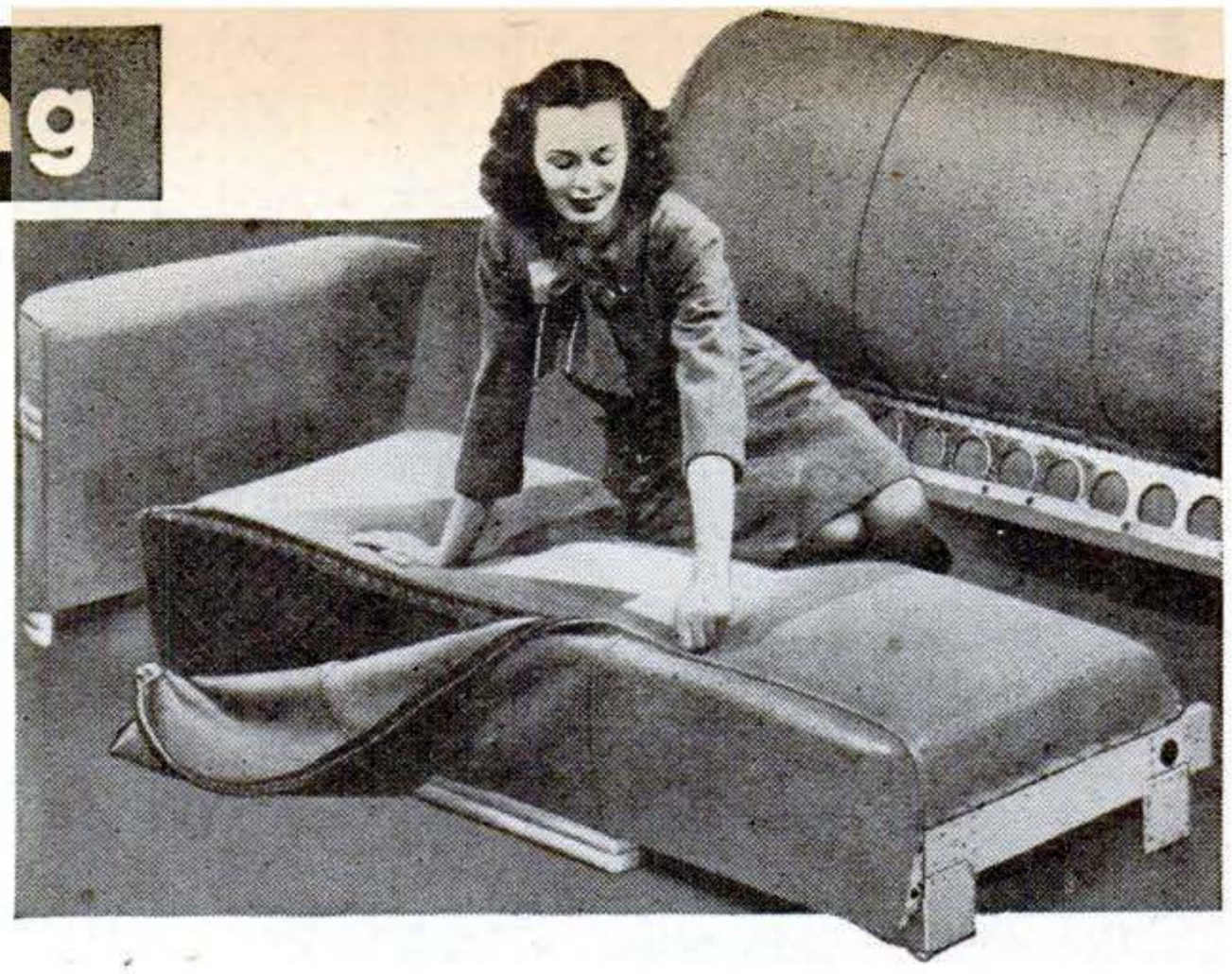
modern living

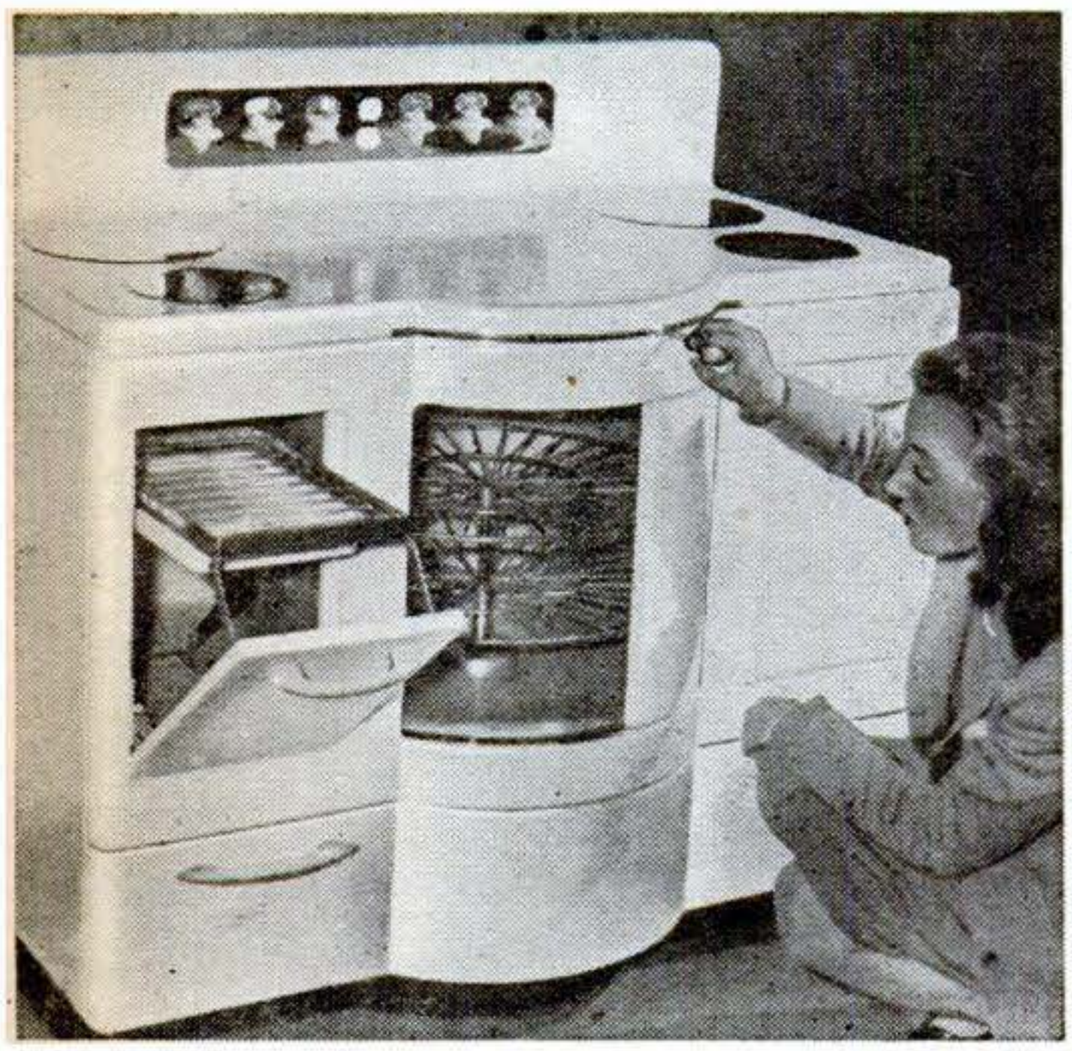
BOILED EGGS may be opened without burning the fingers by use of the holder below, manufactured by J. H. Millholland & Co., Philadelphia. After an egg has been taken from the boiling water and placed on a table, the holder is placed over it and a heat-resisting fabric loop is squeezed. This holds the egg against an aperture in a metal plate, and the end then can be cut off with a sharp knife.

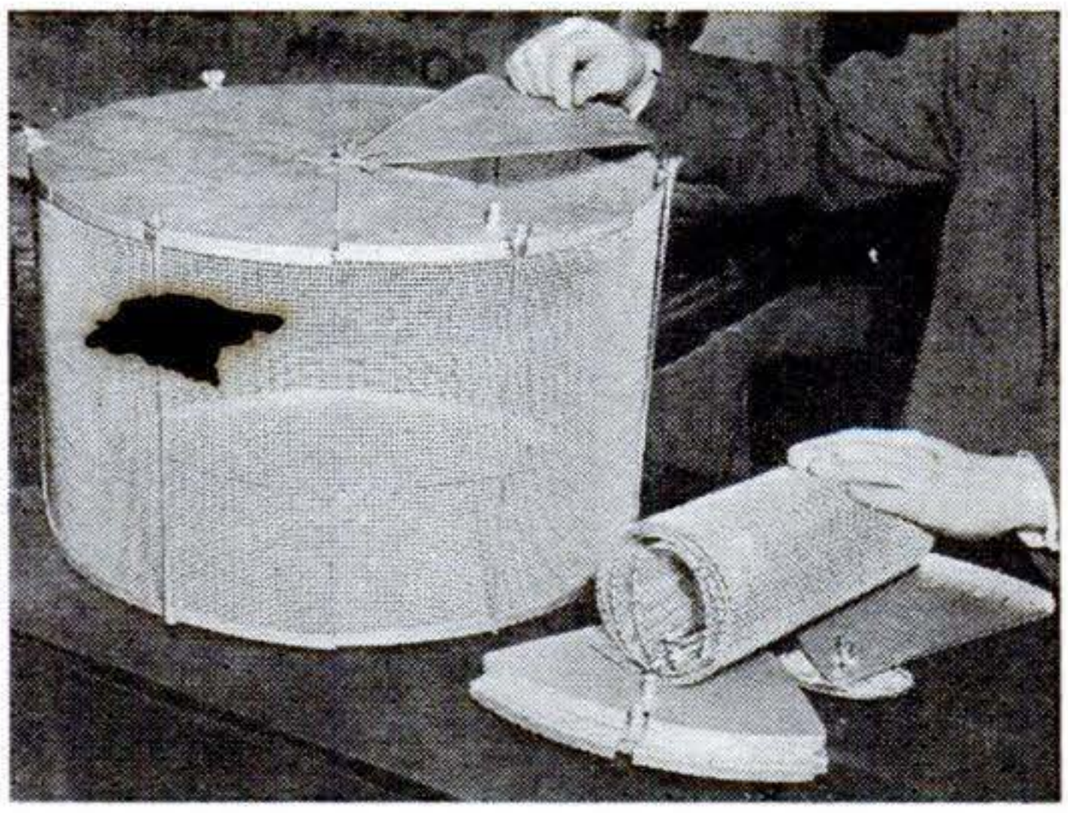




SECTIONAL FURNITURE with an aluminum frame and removable upholstery has been developed by the San Hygene Upholstery Co., of Akron, Ohio. Quick-acting fasteners allow each piece to be separated into four basic units—back, two arms, and base. The covers, which are cut over templates at the factory to insure exact fit, can then be zipped off for dry cleaning, or a cover of a different fabric or color can be substituted if the housewife wants a new decorative scheme. Plastic molding snaps on and off. Because of the light weight of the aircraft-type aluminum frame, designed by Goodyear Aircraft Corp., handling of the furniture is an easy task.

A REVOLVING OVEN and a rotary door, both operated by a handle that can be moved in a slot, are features of a stove invented by Robert G. Rutledge, of Ann Arbor, Mich. The broiler also slides out when you open the door of its compartment.





FOR EASY CARRYING, the live bait box above may be collapsed into a bundle that occupies less than a cubic foot of space when placed in the case that comes with each box. Quickly assembled without tools of any kind, the rustproof sections provide a box 12″ high and 20″ in diameter for keeping either fish or bait alive when you are on a fishing trip. The box is distributed by Schallman Sales, of Chicago.

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Fitting and Rigging the *Alert*

PART II

By Frederick Aeschbacher

WHEN the hull of the scale model of the revenue cutter *Alert* has been completed (P.S.M., July '46, p. 149), you will be ready to add the superstructure, fittings, and rigging. The rudder should be fitted on the sternpost by riveted pintles and gudgeons before the hull is painted. Shape the gudgeons around pins, and fit the rudder close to the sternpost.

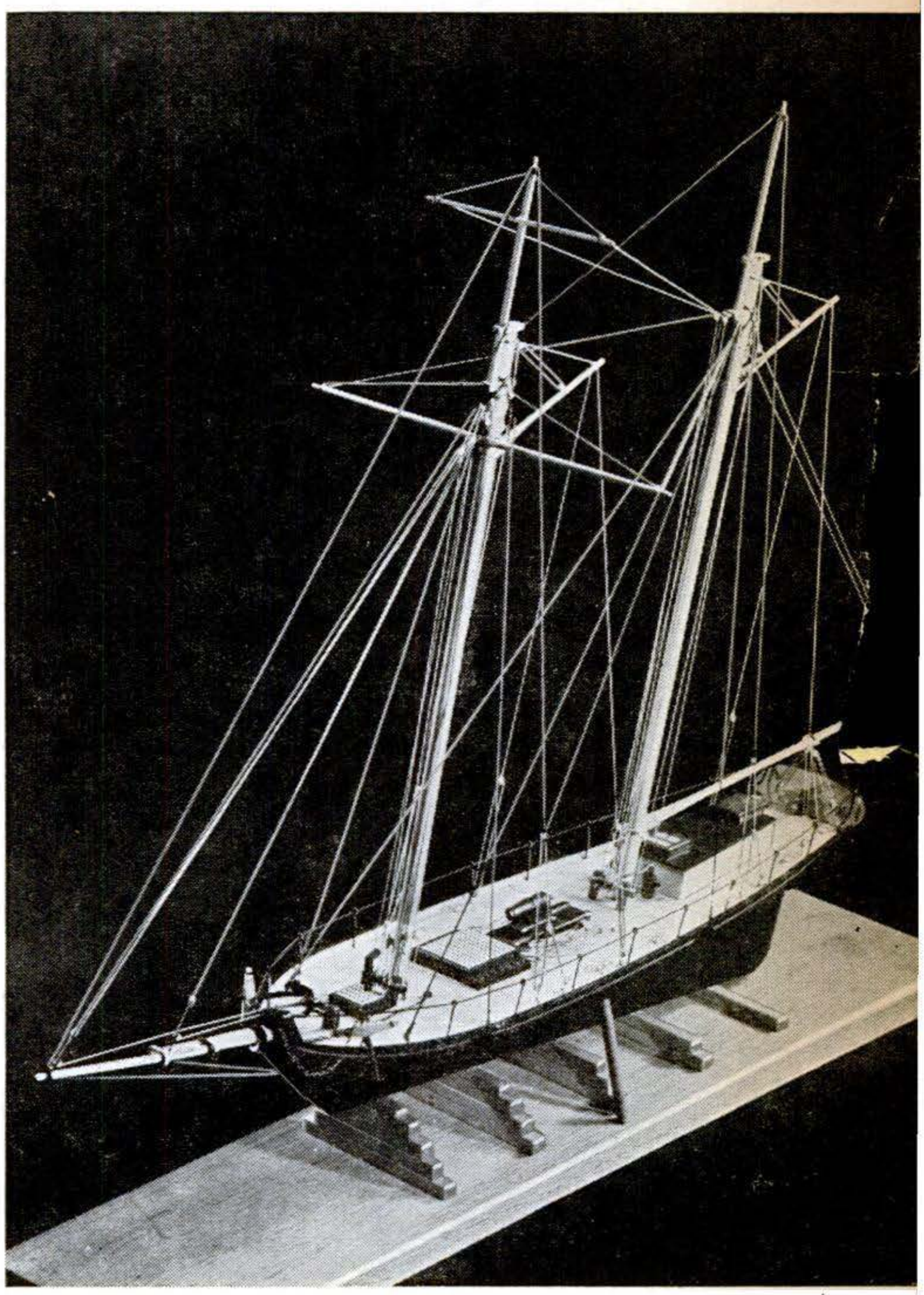
The pintles, gudgeons, and other parts, including the channels, are shown full size on pages 162 and 163. Attach the channels to the hull in line with the mast holes. The inner edges of the channels conform to the shape of the hull.

Gratings for the hatches can be purchased from a model-supply store. Racks at the sides of the main hatch each hold seven ⅛" bearing-ball "shots." The carronade is turned complete from wood or brass or whittled from a dowel and fitted with wire rings.

Make the 3 7/16" long bowsprit from 3/16" square pine. Leave it square where it passes through the bitts, then form an octagonal section, gradually tapering it to 5/32" round at the end. File the end square to fit a square hole in the cap, which has also a round hole to take the jib boom. Lemonwood is best for this and the two mast caps. Note that the holes in the latter slant so the caps parallel the waterline despite the rake of the masts.

The two masts are similar except for the mainmast boom seat. Make them of ¼" dowel cut for a 10¾" length above deck and sanded to taper to 3/16" diameter at the trestletrees, above which they are ⅛" square. The topmasts are lemonwood, ⅛" square at the trestletrees and then rounded off after a short octagonal length. Taper to 3/32" in diameter and sand the top ¼" to 1/16" diameter. The squaresail yard is ⅛" dowel and the flying topsail yard 1/16" tapered toward the ends. All eyebolts for rigging are 1/32" diameter except those for the main jumper stays, which are 1/16".

Spars are white, as are both masts up to



This mount is made of ¼" graving blocks and 3/16" shores, and the model is pressed down on pins.

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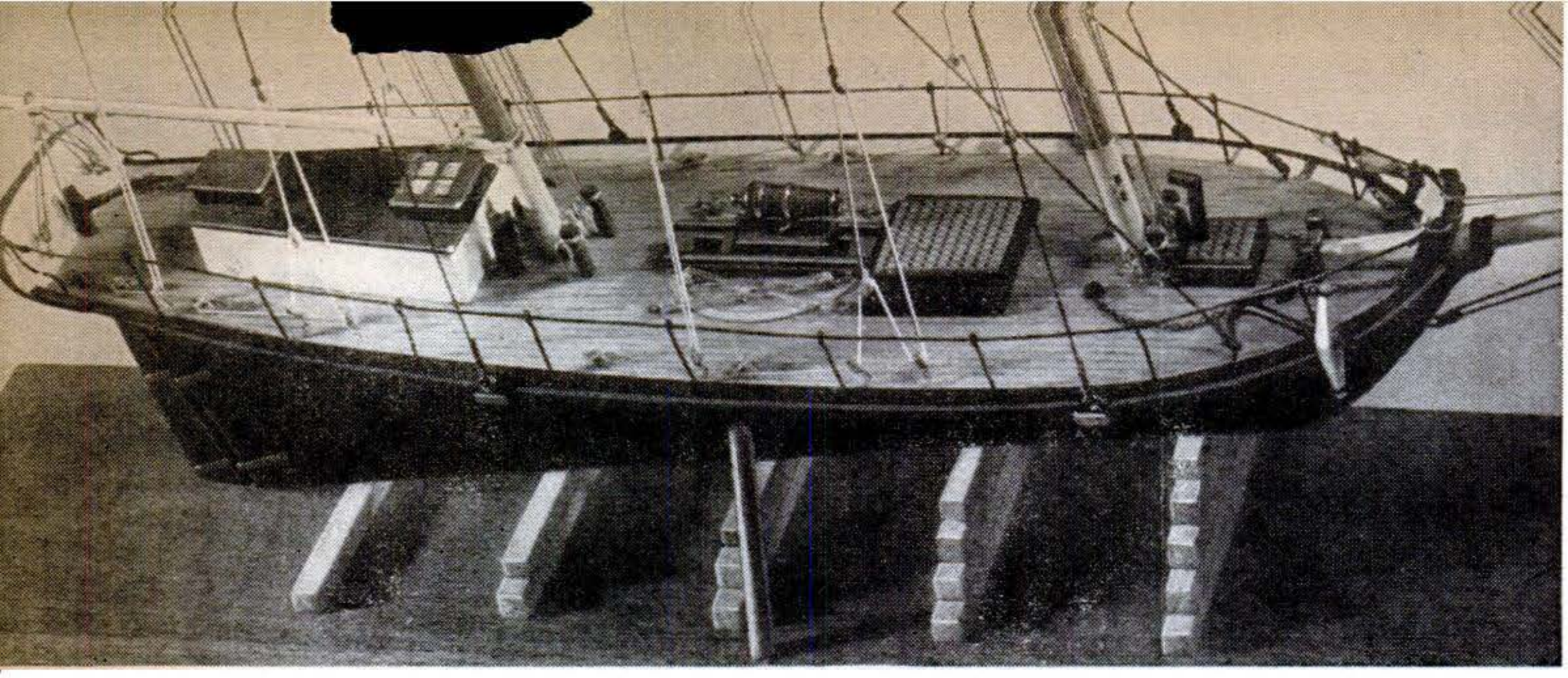
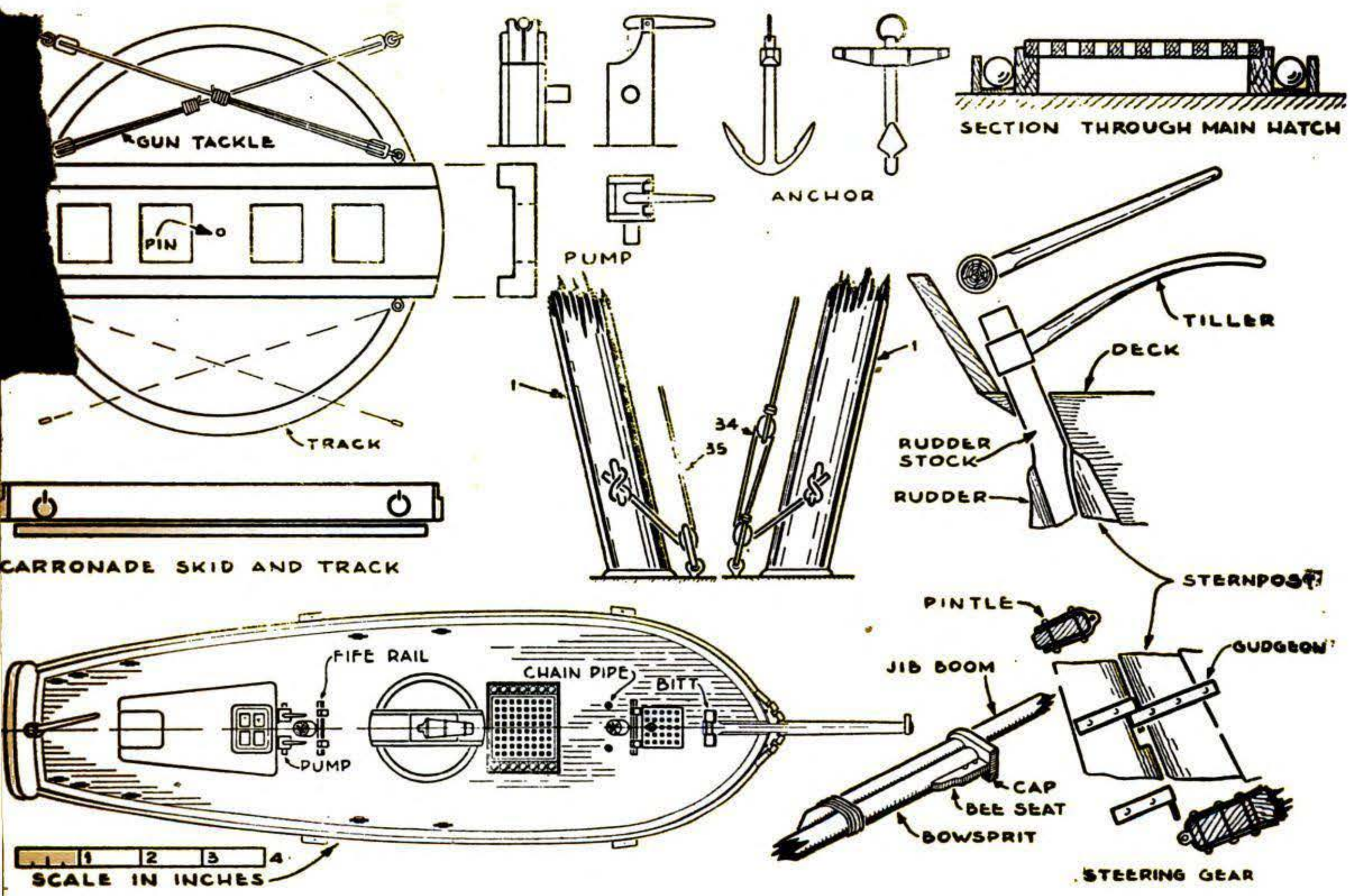


Deck rigging and superstructure are shown in this topside view, and on the facing page is rigging aloft.

the height of the boom seat on the mainmast. The dark parts in the photos are black except for the tiller and fifes, which are brown; lighter parts are natural, and the parts showing white are white.

Seize the shrouds, main jumper stays, forestays, and jibstay to the masts before stepping them. Then reeve the shrouds through the bull's-eyes from outboard in, and reeve the forestay through a hole drilled in the bee seat and one between the bowsprit and jib boom. Drive a small staple in the stem for the bobstays and seize them. Do not allow the jib boom to curve upward.

Seize an eye in each backstay to fit the shoulder on the topmast. Then cut to length and with a slip knot splice in a ⅛″ single block. The tackle also has a ⅛″ single block spliced in one end. Reeve it through the stay block to a ⅛″ single strapped block on a 1/32″ eyebolt in the deck at the waterway, and then through the tackle block to



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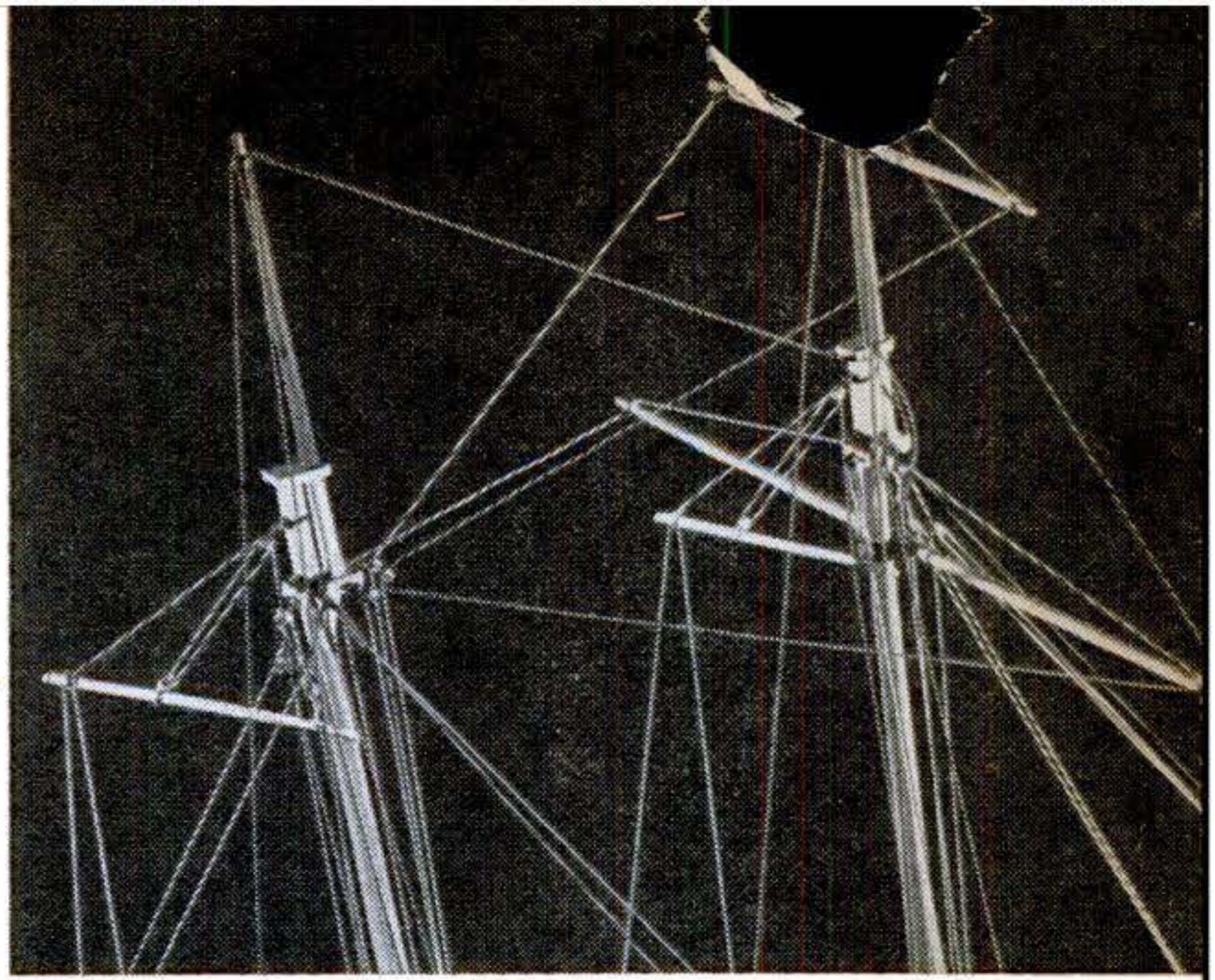
another block on deck. The free end is belayed to a 5/16″ wooden cleat. All stays and tackle are the same.

The boom is held with cord rove through holes in the jaws and knotted outside. Reference to the key numbers shows placement of the sheets and topping lifts. The gaffs are rigged the same way, and then the main topmast stay is seized around the topmast over the backstays and forward and the foremast close under the cap.

Suspend the squaresail yard with a sling and hold it to the mast with a truss, as shown below, and then rig as in the drawing in Part I. The flying topsail yard is held with a lashing through two eyebolts in the saddle. When setting up the forestay, take care that the stays previously put on do not sag. Splice an eye in one end to fit the topmast, carry it under the jib boom, haul it up as with the shrouds, and seize.

The rail stanchions go on after rigging. Make them of No. 20 enameled wire and bend an eye for the life line. Drill holes in the deck just inside the rails so they project ⅝″. Seize No. 9 black rigging cord to the taffrail braces for the life line, reeve through the stanchions, and seize to the aft timber head on the hawse timbers.

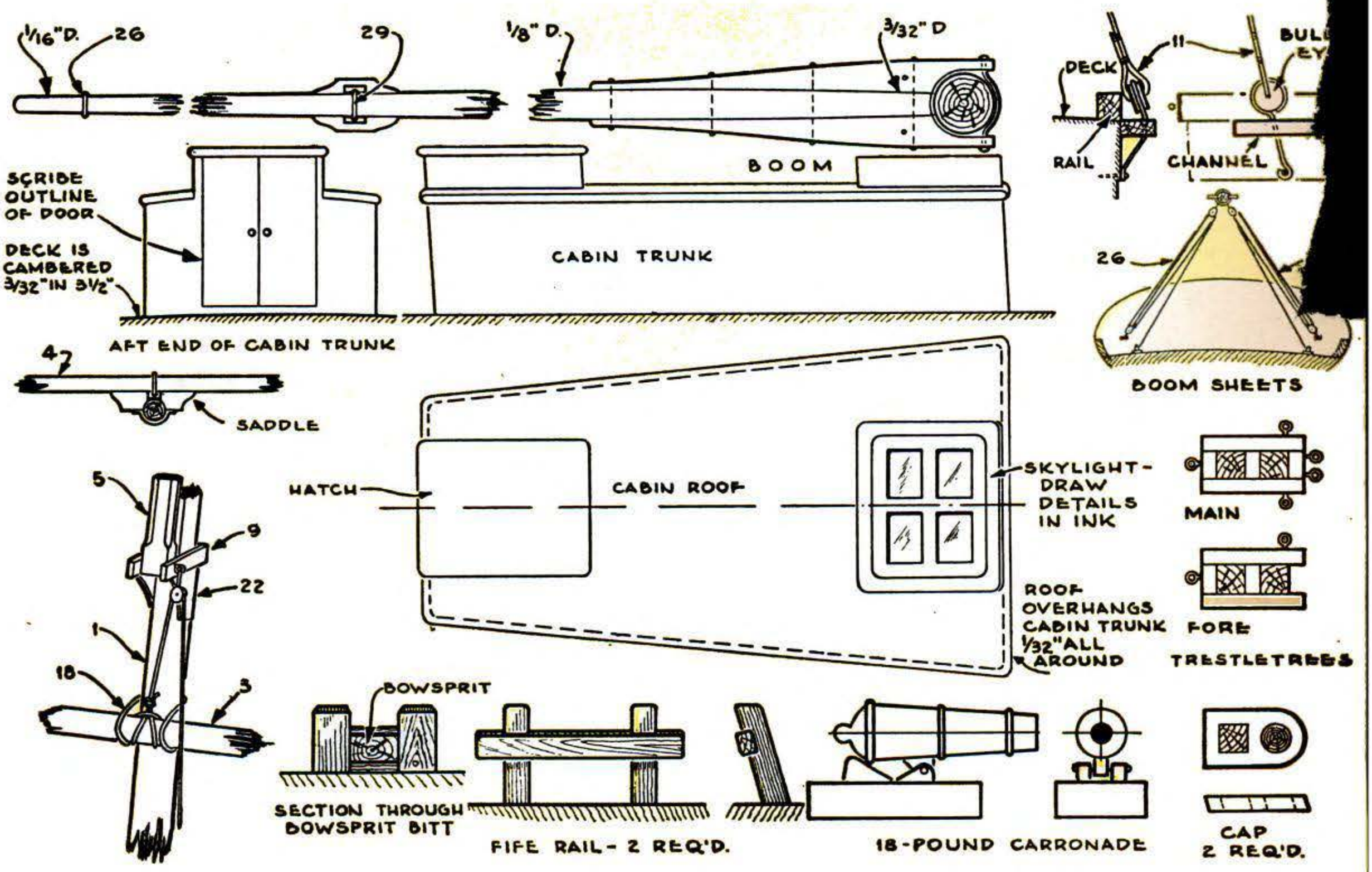


Key to Rigging

Letters in parentheses following the names of parts of rigging indicate the size of cord to be used: (a) No. 9 black, (b) No. 4 black, (c) No. 3 black, and (d) No. 80 natural. All standing rigging is black, and running rigging and tackle are light brown.

1. Masts.
2. Boom.
3. Squaresail yard.
4. Flying topsail yard.
5. Topmasts.
6. Bowsprit.
7. Jib boom.
8. Gaffs.
9. Trestletrees.
10. Caps.
11. Shrouds.
12. Topmast backstays (b).
13. Forestay (b).
14. Jibstay (b).
15. Fore top stay (c).
16. Bobstays (b).
17. Main jumper stays (a).
18. Truss (b).
19. Topping lifts (d).
20. Vangs (d).
21. Main topmast stay (b).
22. Bibs.
23. Throat halyards (d).
24. Peak halyards (d).
25. Lifts (d).
26. Sheet (d).
27. Fore braces (d).
28. Fore top sailbraces (d).
29. Topping lifts, P & S (d).
30. Staysail halyard (d).
31. Jib halyard (d).
32. Staysail downhaul (d).
33. Jib downhaul (d).
34. Squaresail halyard (d).
35. Flying topsail halyard (d).

Note: See P.S.M., July '46, p. 150, for key numbers not shown in the accompanying drawings.



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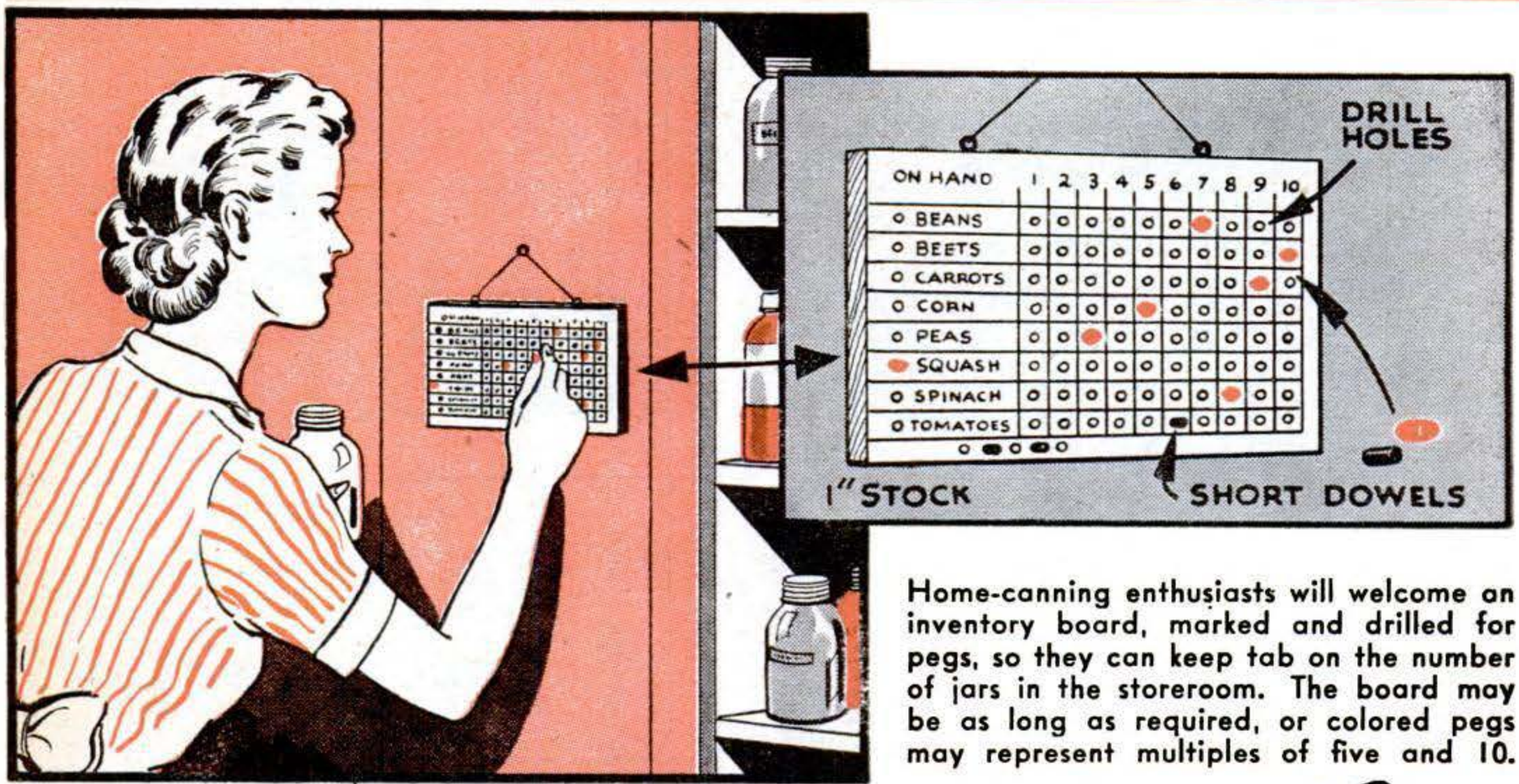
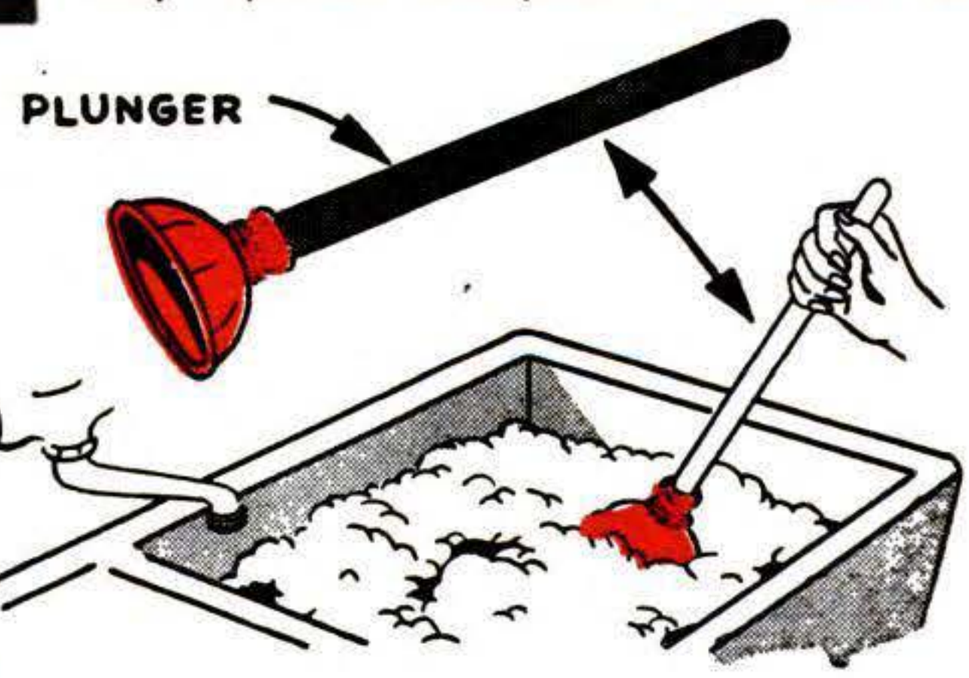
KEEPING THE HOME



Home-canning enthusiasts will welcome an inventory board, marked and drilled for pegs, so they can keep tab on the number of jars in the storeroom. The board may be as long as required, or colored pegs may represent multiples of five and 10.

Identifying initials that stand up under any amount of wetting can be put on toothbrush handles with fingernail enamel. Then each member of the family can tell his brush at once regardless of general similarity in color and size.

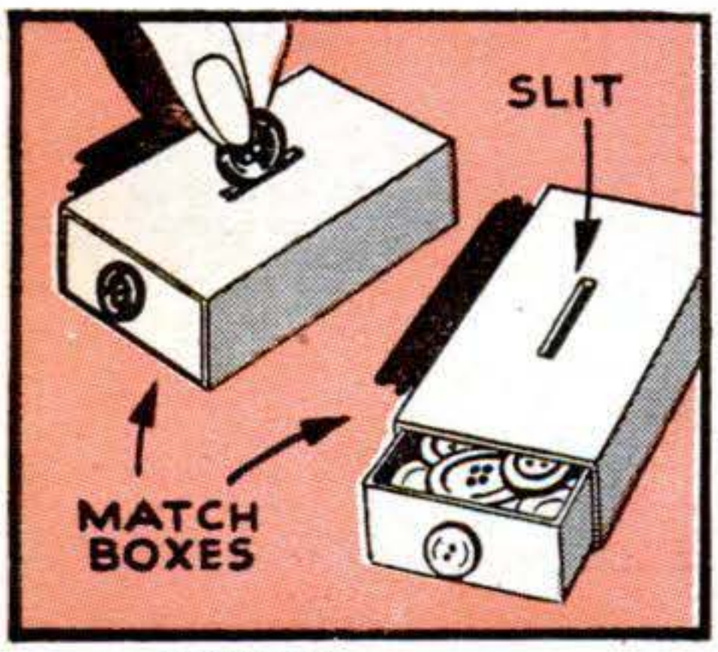


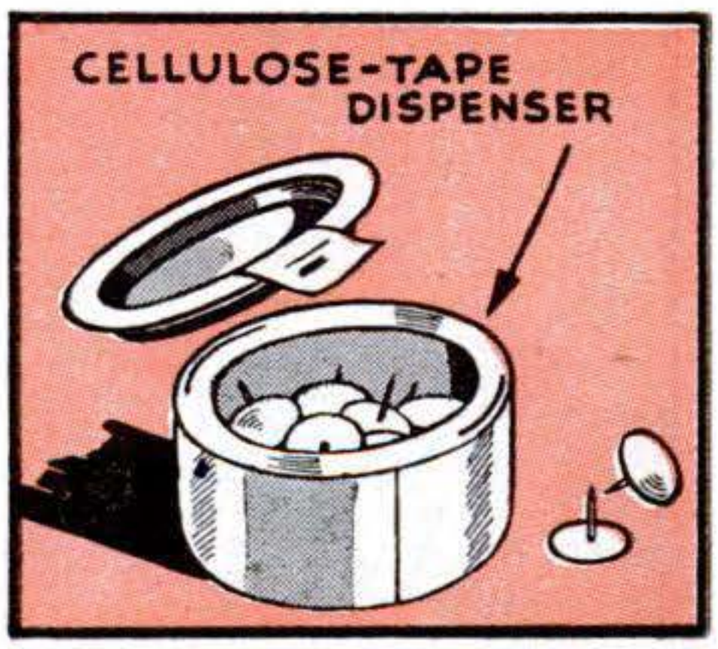
Blankets, rag rugs, and other bulky articles are washed easily when they are jogged up and down in the tub with a plunger of the type used to open drains. The plunger is also handy at a summer cottage that has no electric washing machine.

Kept handy in the laundry, matchbox "button banks" are receptacles for loose buttons that might otherwise be lost. Cut a slot in the box top and glue a sample on to identify the size and color.

Vacuum-bottle corks won't absorb odors from, or be stained by, the contents of the bottles if they are protected, as shown below, by waxed-paper cups of the kind used for candy.

Thumbtacks, notebook reinforcing rings, and the like can be kept conveniently at hand in the core of a roll of cellulose tape. Put a double-tape tab on one of the metal ends for use as a lid pull.





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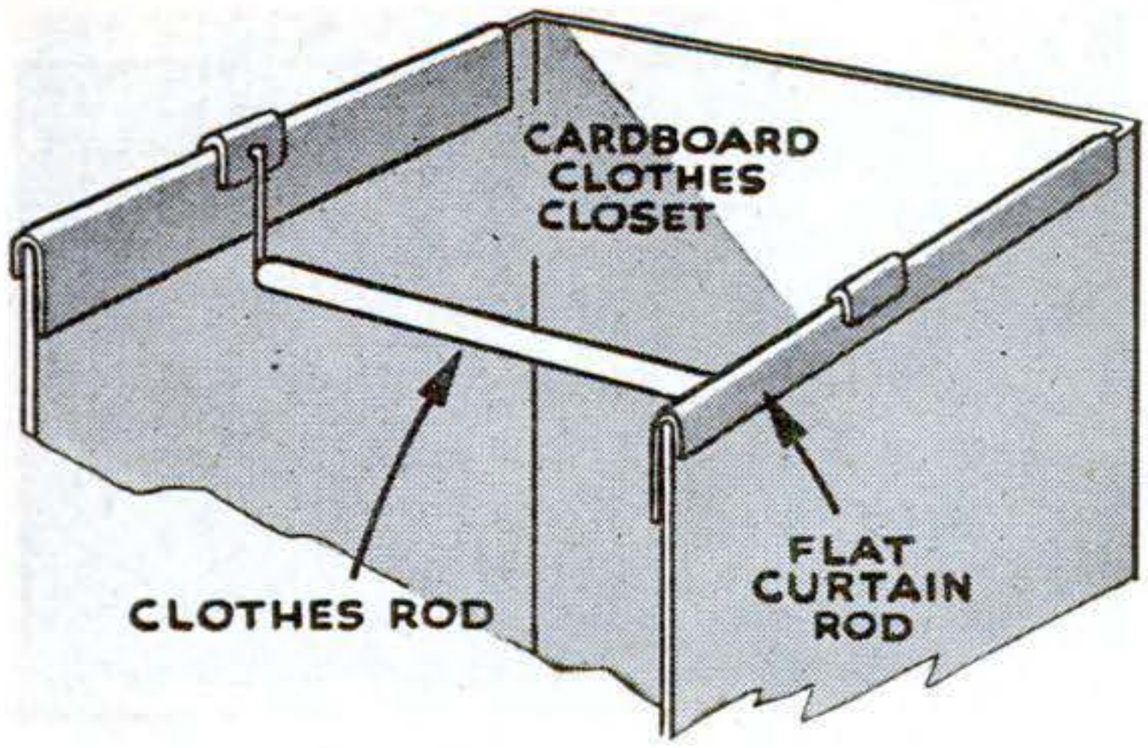
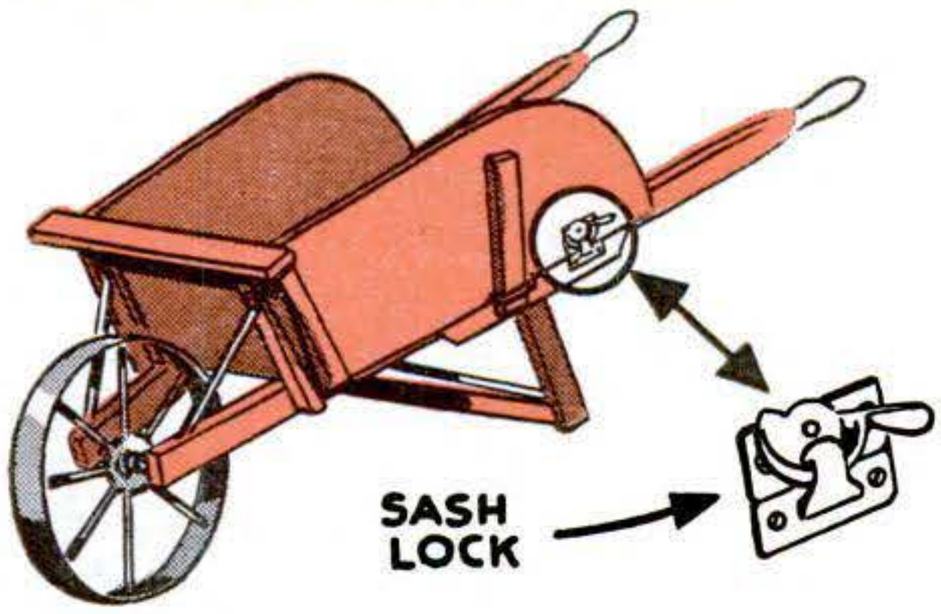
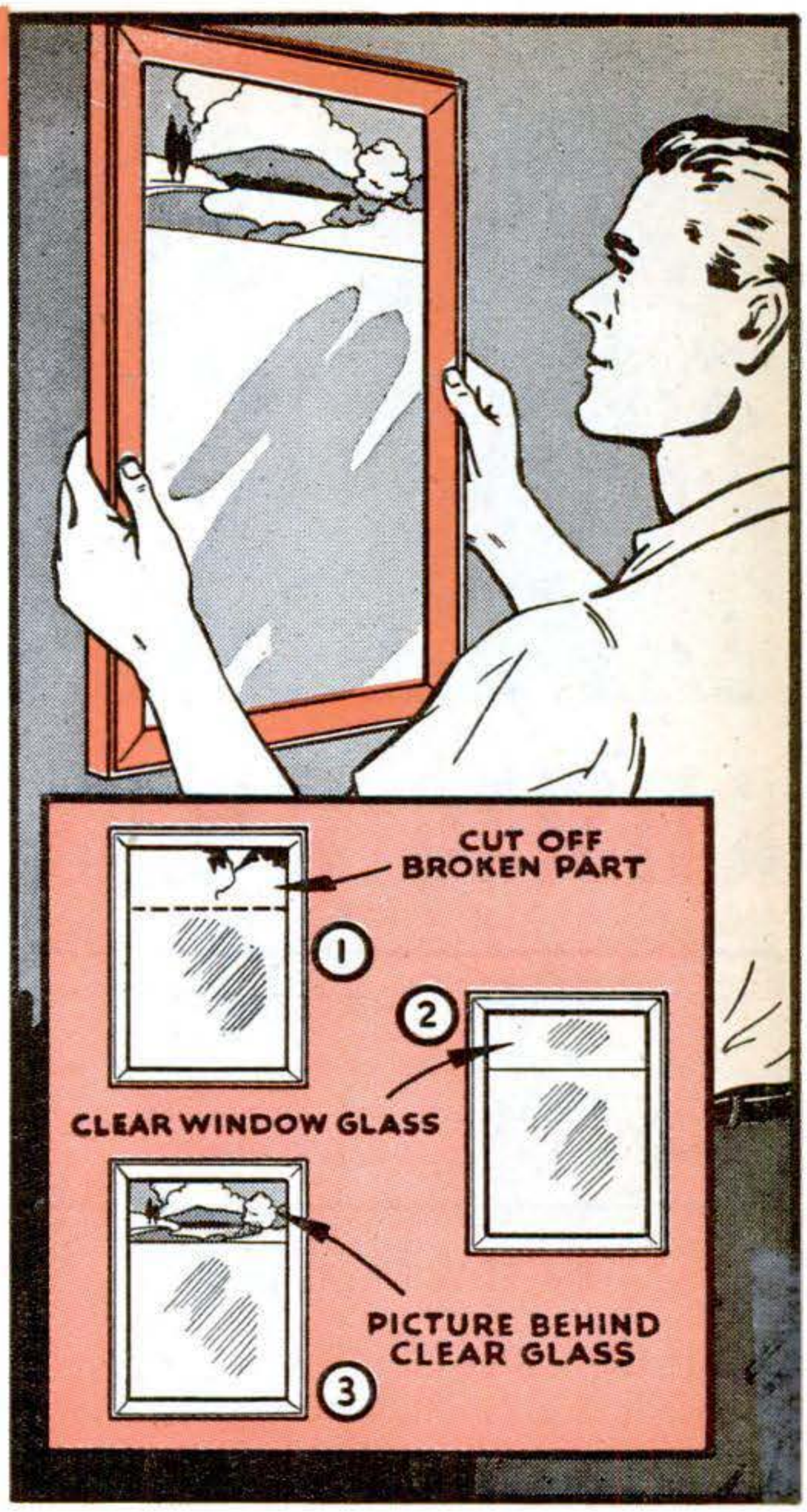
SHIPSHAPE



Two lengths of flat-type curtain rod with one of the channel edges bent out straight and hammered flat increase the strength of a cardboard clothes closet. Place one on the top edge of each side and put the regular hanger back in position. The sides will then take a much heavier load.

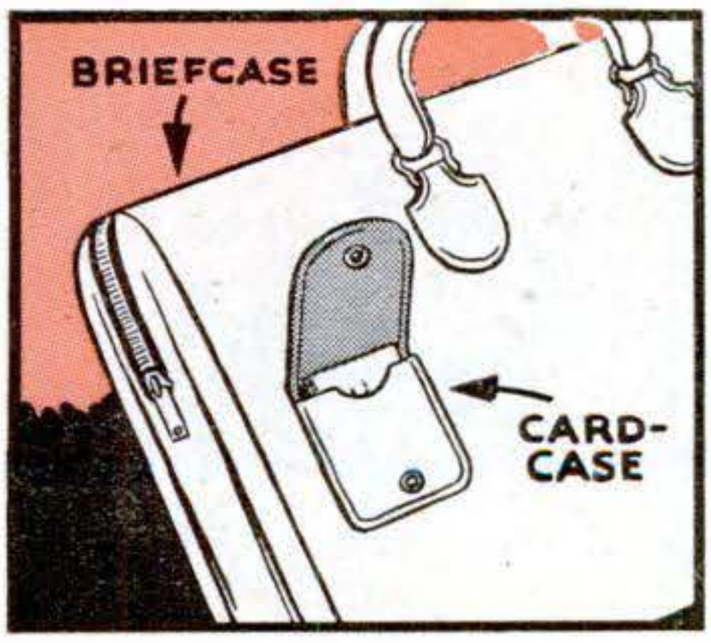


A window-sash lock installed on each side and the bottom of a wheelbarrow with removable sides will hold one or both sides securely when the load is dumped. The locks are released easily when the wheelbarrow is wanted for use without sides.

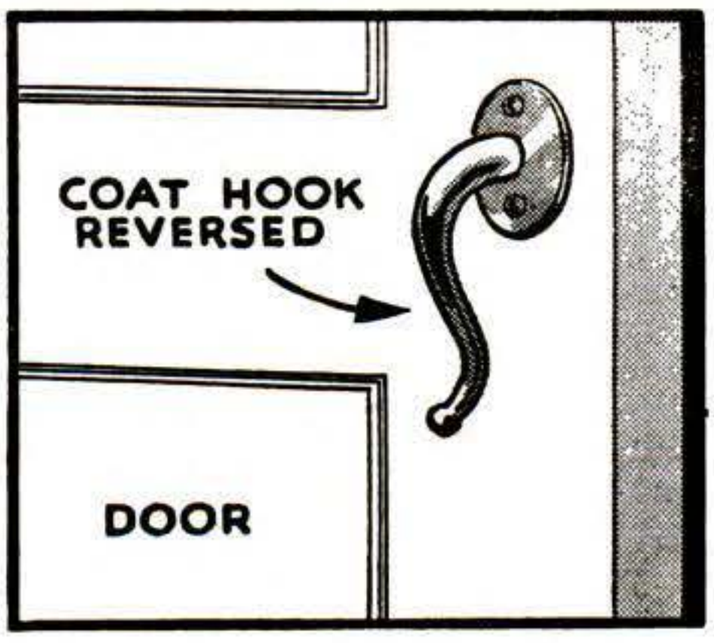


Fairly long mirrors cracked or broken at one end can be restored to use as ornamental art mirrors. First, remove the frame and cut off the damaged end; then fit in a piece of clear window glass and reframe with a favorite picture in place.

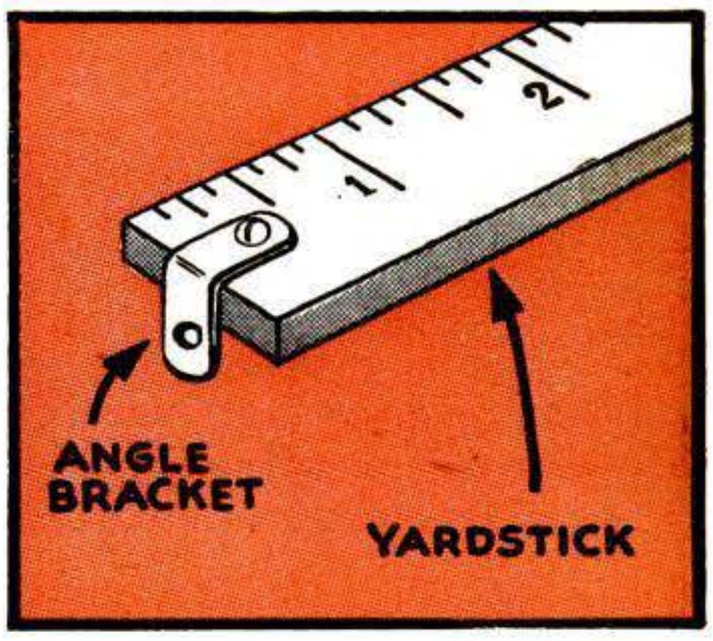
Fumbling around in a briefcase or pocket for business cards is eliminated by sewing or riveting the cardcase to the side of the briefcase. Use a cardcase with a flap to protect the cards.



Coat hooks of the kind shown in the drawing below make good door pulls when turned upside down and screwed on. Be sure not to put one too near a lock requiring a key.



A small angle bracket screwed on one end of a yardstick will add to the ease with which boards and the like can be measured. Simply hook the bracket over the end for a positive starting point.



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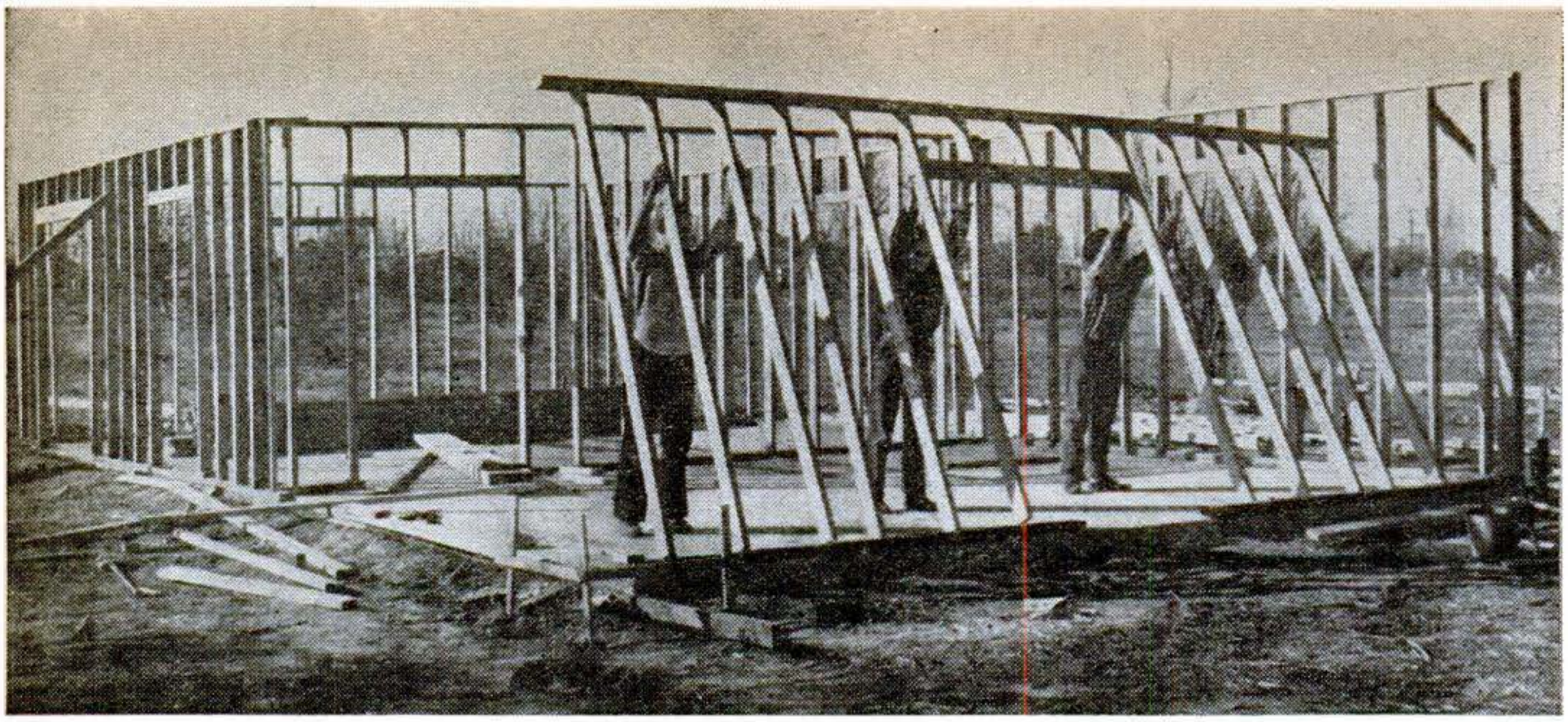

RAISING WALLS on a SLAB FLOOR

THIRD OF A SERIES

Walls and partitions of a small house are raised and braced and the ceiling joists added in this step in construction.

By EDWIN M. LOVE

BUILDINGS begin to take form when the walls are raised, and a great show of progress is made at this stage. But still ahead is a good deal of detail work that largely determines the life of a structure.

A wall is ready for raising when the studs have been nailed to the upper plate and the upper trimming headers and cripples for doors and windows have been placed. If several men are on the job, assemble the frame for a long wall while it is lying flat; but if only two or three are working, or the wind is blowing, raise it section by section, with each section consisting of a length of plate with its studs. Butt the feet of the studs against the sill, lift the plate, and walk forward, pushing the frame to an upright position with the studs resting on the sill.

Two men can steady the wall while a third nails the feet of the studs. If there are only two men, 1″ by 6″ braces can be nailed to several studs under the plates and the far ends tacked to plates across the room or to

In plumbing a corner, the straightedge has blocks at the ends for contact at the sill and plate. Ends are sized to equal width.

At the opposite corner the frame is pulled or pushed until the bubble shows plumb. A stiff corner is being moved here by springing a 2″ by 6″ against it.

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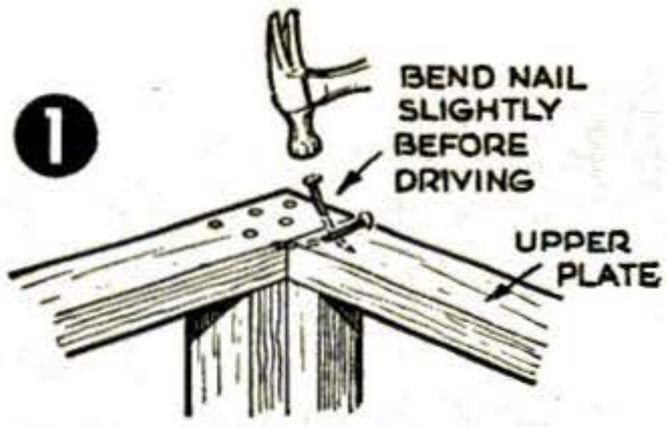
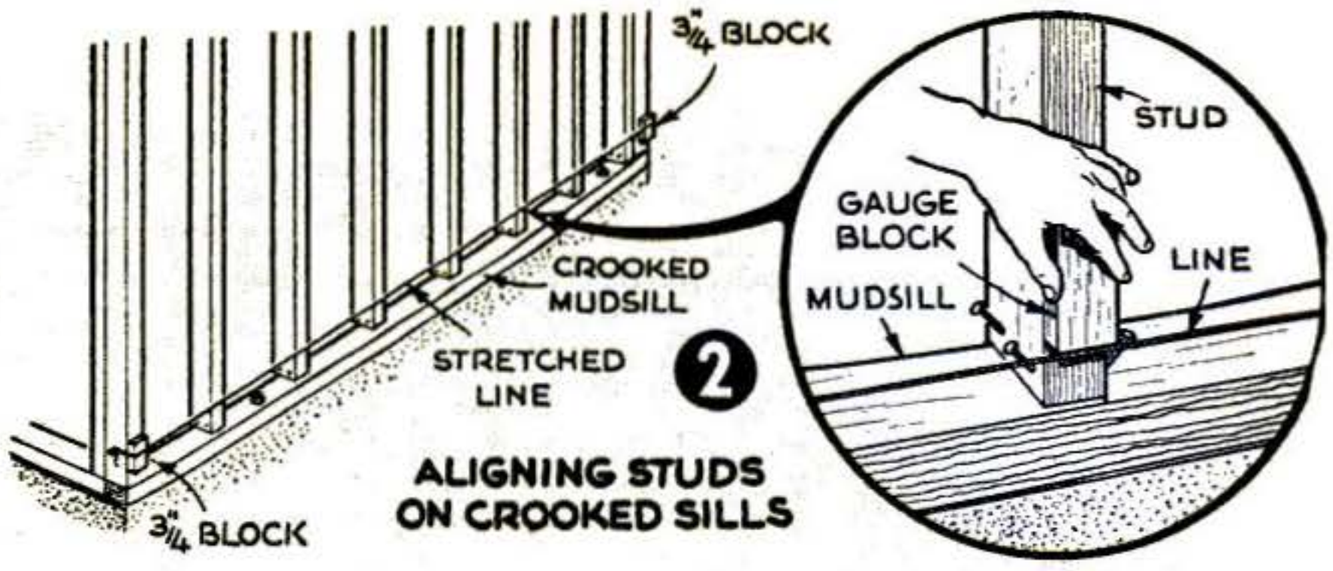
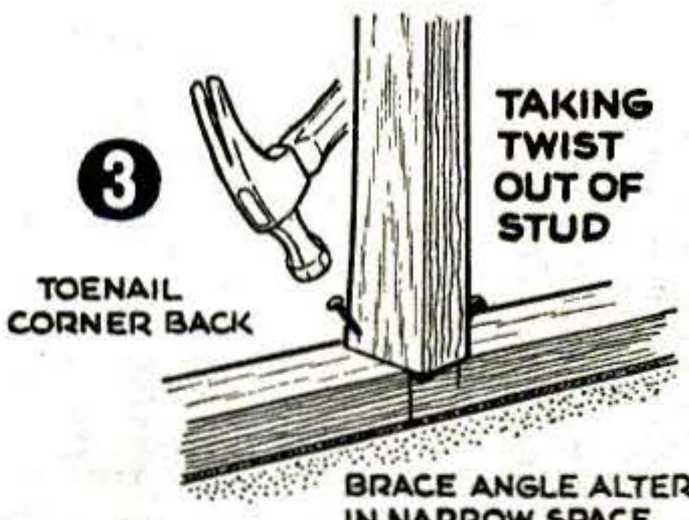
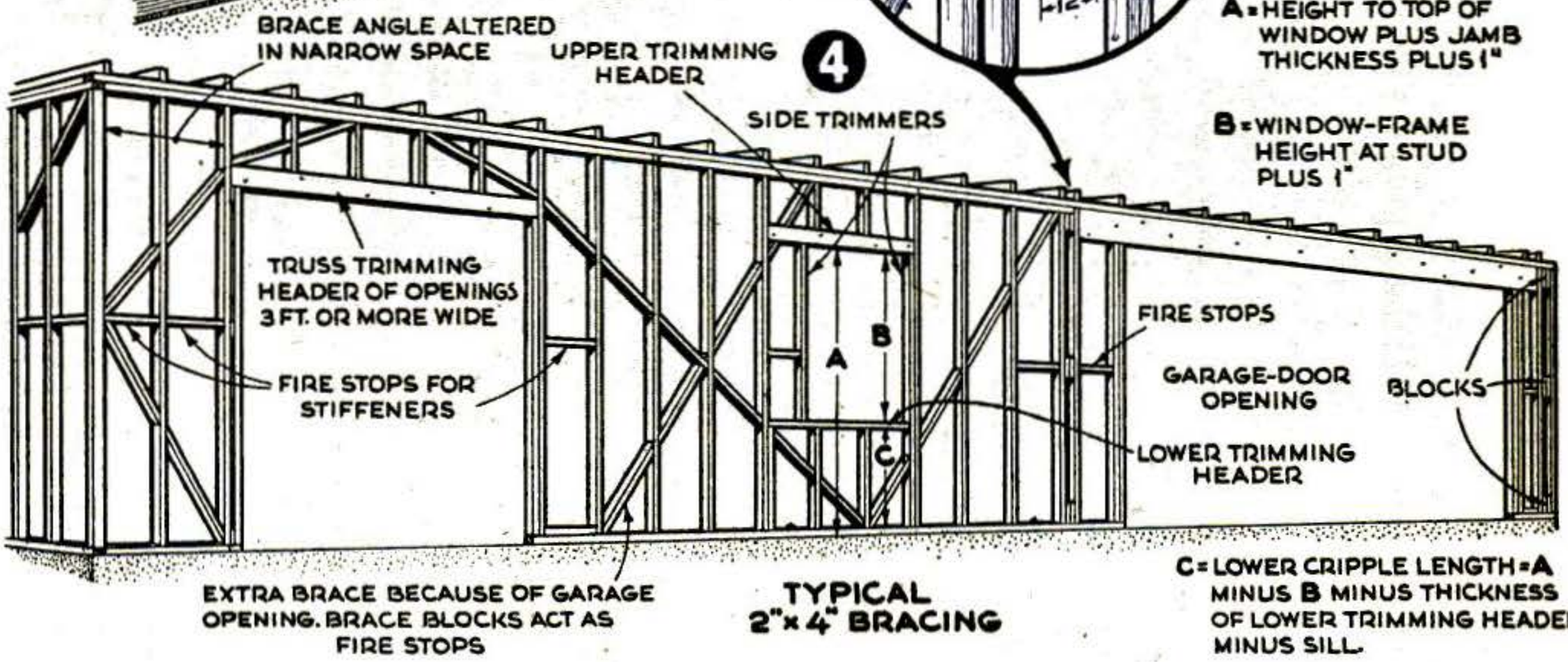


DRAWING CORNER TOGETHER

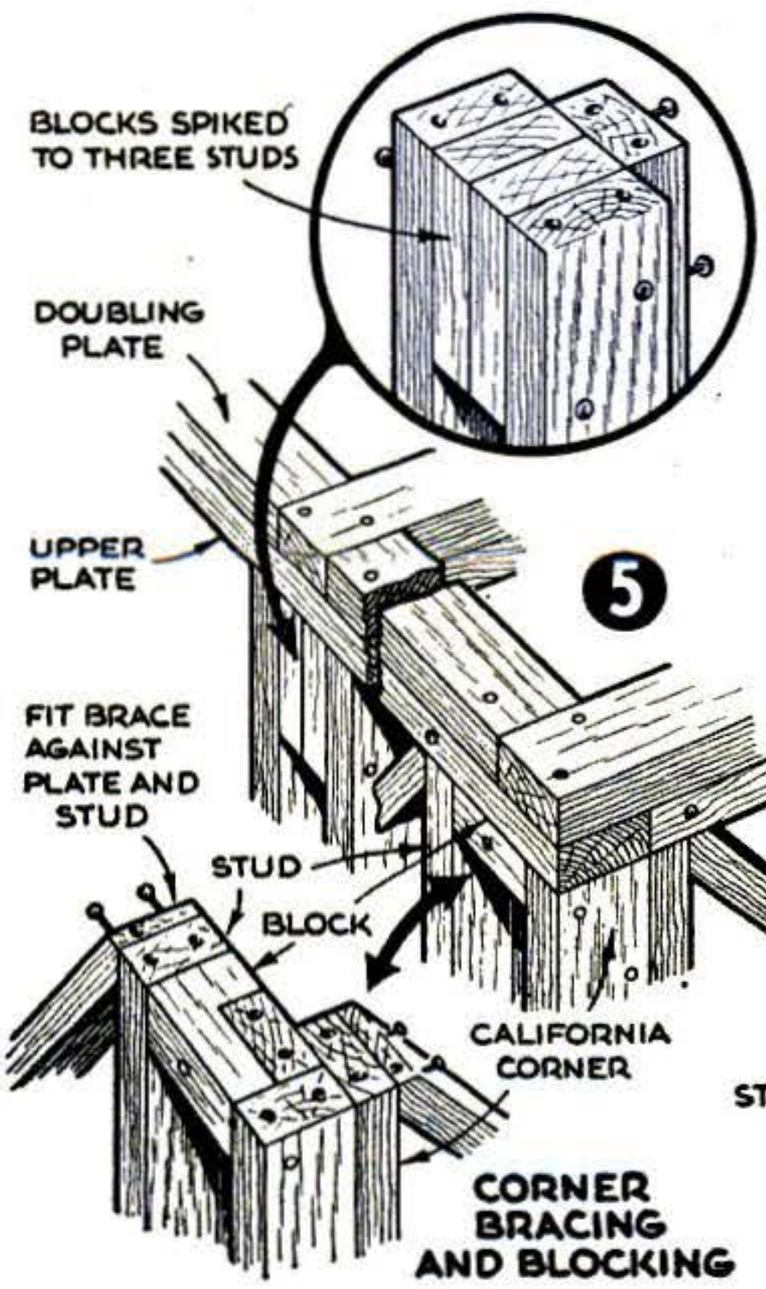


ALIGNING STUDS ON CROOKED SILLS

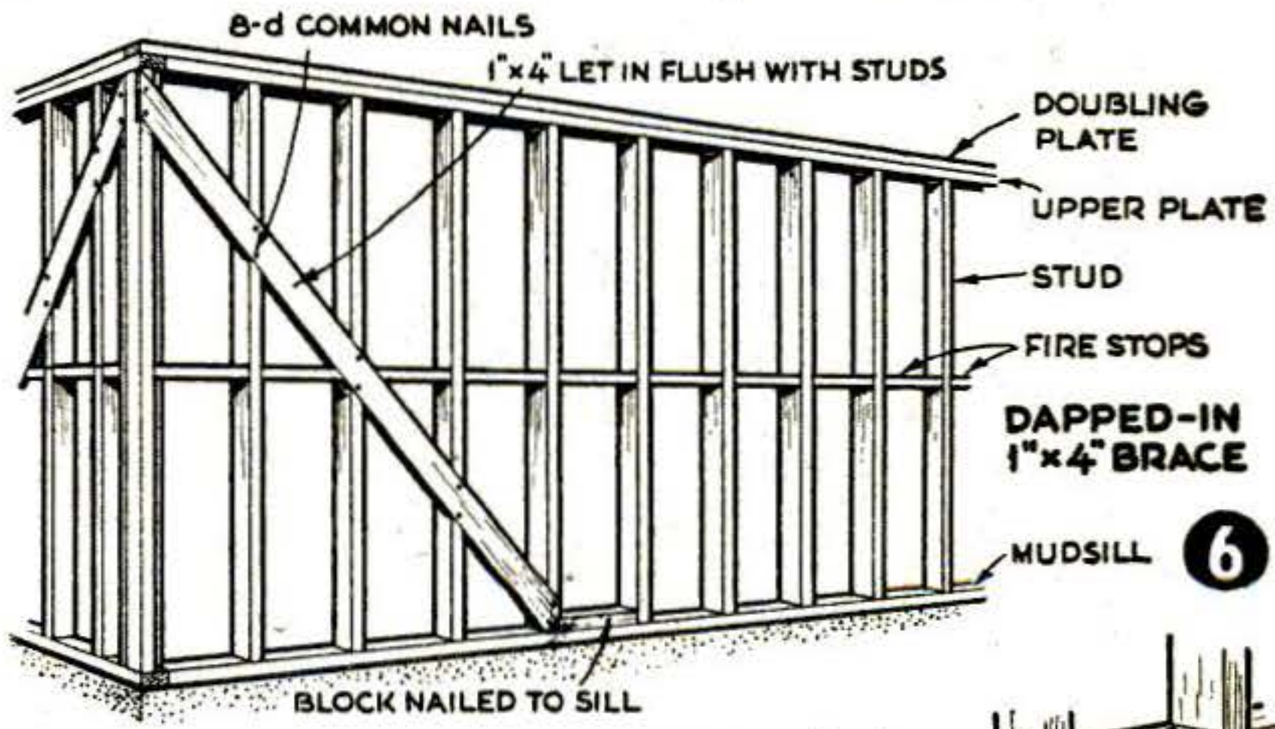




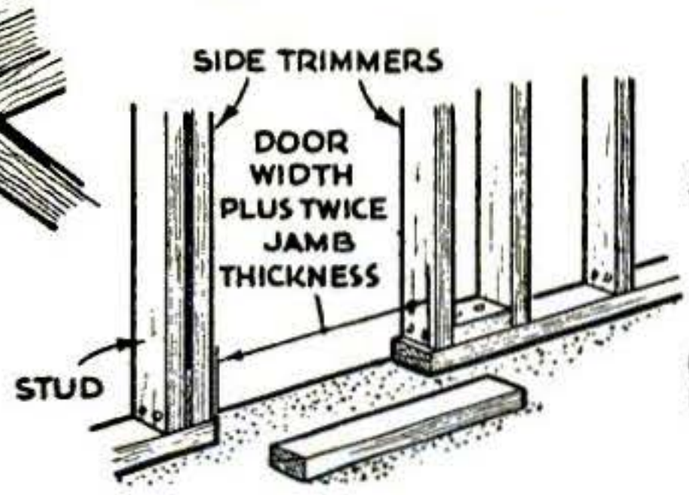
TYPICAL 2"x4" BRACING



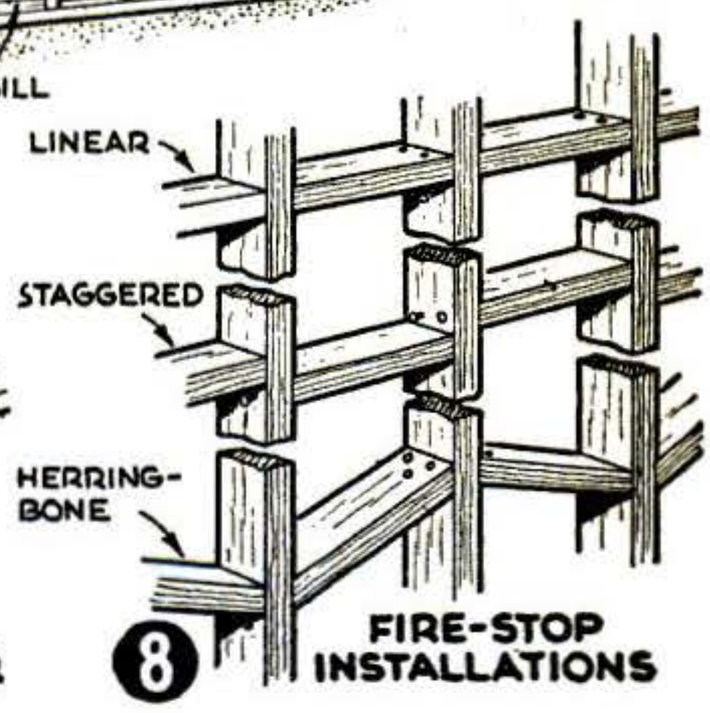
CORNER BRACING AND BLOCKING



DAPPED-IN 1"x4" BRACE

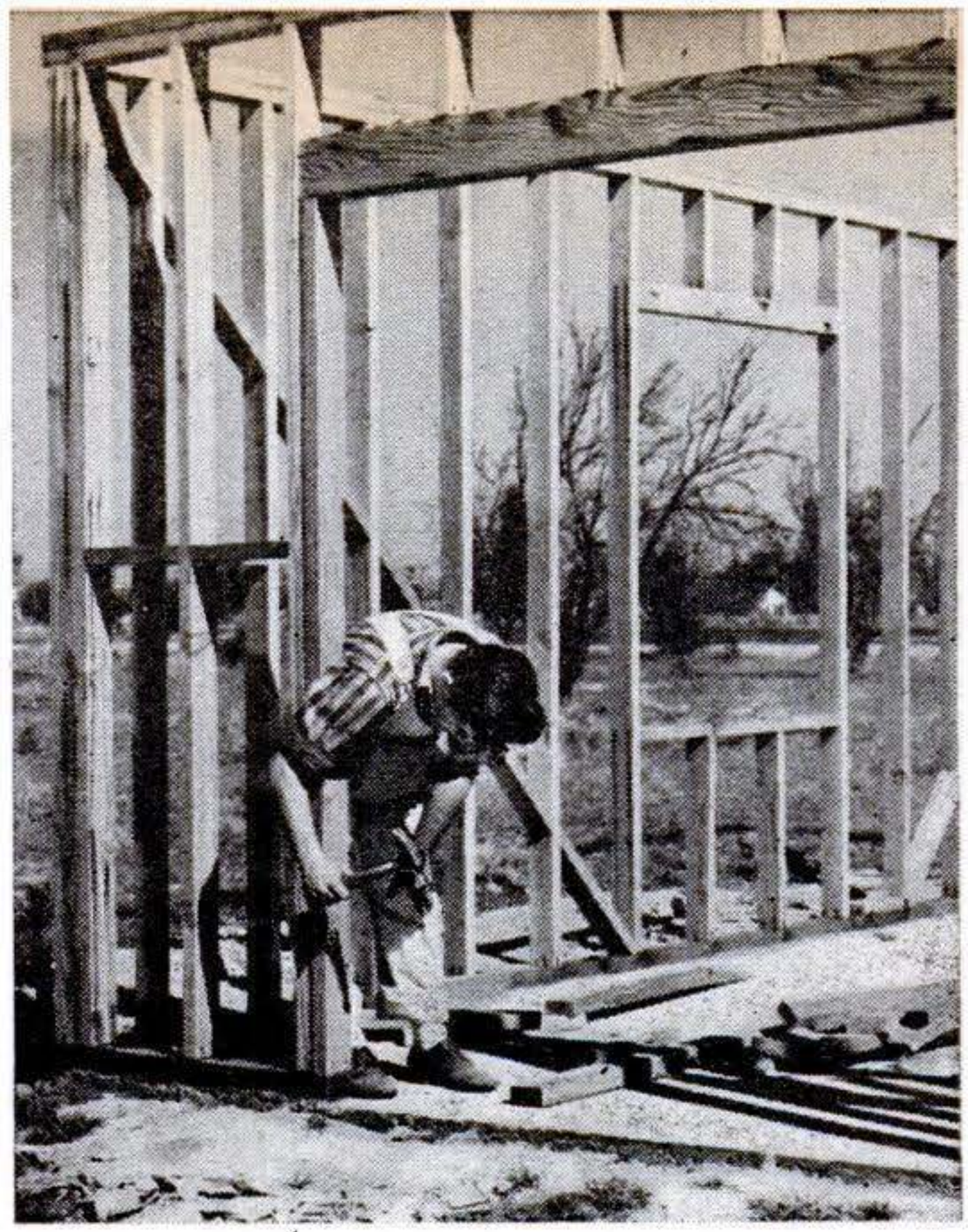


7 CONTINUOUS SILL CUT OUT FOR DOOR



8 FIRE-STOP INSTALLATIONS

Side trimmers are cut a little long, driven tight between the headers, and then accurately plumbed.



Nailing the foot of a door trimmer after the sill has been cut away for the opening, as in Fig. 7.

stakes in the ground outside. A second section of wall at right angles to the first is next raised to help in bracing. Draw the plates together at the joint by driving 8-d. nails that have been slightly bent, as shown in Fig. 1, to guide them in curved.

Usually the mudsill is straight and the studs can be aligned with it. If one is crooked, nail ¾″ blocks to the corner studs, stretch a line, as in Fig. 2, and gauge the distance of each stud from the line with a ¾″ block held against the edge. The foot of a twisted stud can be squared with the sill by toenailing first into the corners that should be driven back, as shown in Fig. 3.

When all walls have been raised, brace them temporarily with 1″ by 6″ boards placed diagonally in corners with the upper ends held to stud edges under the plates by 8-d. nails driven partly in. Double the plates, lapping the ends at corners and partition intersections, as illustrated in Fig. 4, and driving 16-d. common nails 16″ or 18″ apart. Joints in the doubling plates are preferably made over studs and spaced at least 4′ from those in the original upper plate.

Apply a straightedge and level to a corner of the building while a helper at the loose end of a temporary brace pulls or pushes until the bubble shows it to be plumb. If the structure is too stiff to move by hand, lean a two-by-four or two-by-six against the corner needing to be pushed, drive a stake at the lower end, and spring the piece down until the upper end slides downward. The corner will move when it springs up. Once the corner is plumb, tack the foot of the temporary brace and test the diagonally opposite corner.

If opposite corners do not plumb, inspect the plates for open joints and correct them. Occasionally a plate slips when being laid out and is longer or shorter than the sill. Straighten the top of the wall by extending braces where needed to push or pull.

Whether to brace the walls or trim the openings first depends on several factors. Time is saved if braces are cut from long stock; but if material is poor and many scraps are caused by cutting out knots, the short lengths can be saved by using them for bracing and fire stops. Select straight, sound lumber for side trimmers. When wall spaces are narrow, necessitating steep braces, flatter braces are possible if they can extend under the trimmed windows, as in Fig. 4.

Lower cripples nailed to lower trimming headers will support these headers at the proper height for nailing between the studs. Cripples placed under each end of a header and spiked to the studs give positive support. Cut the side trimmers a little long and

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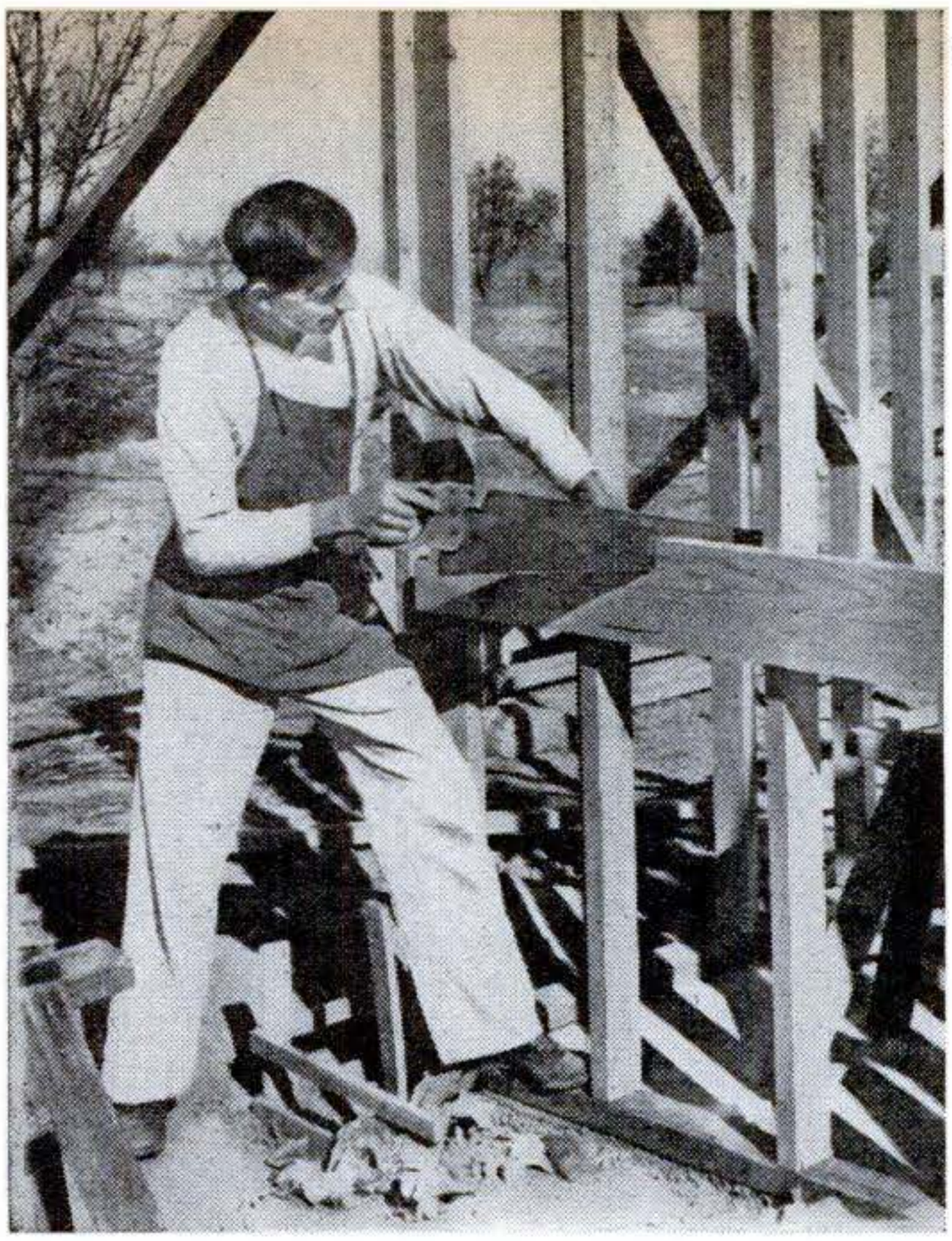
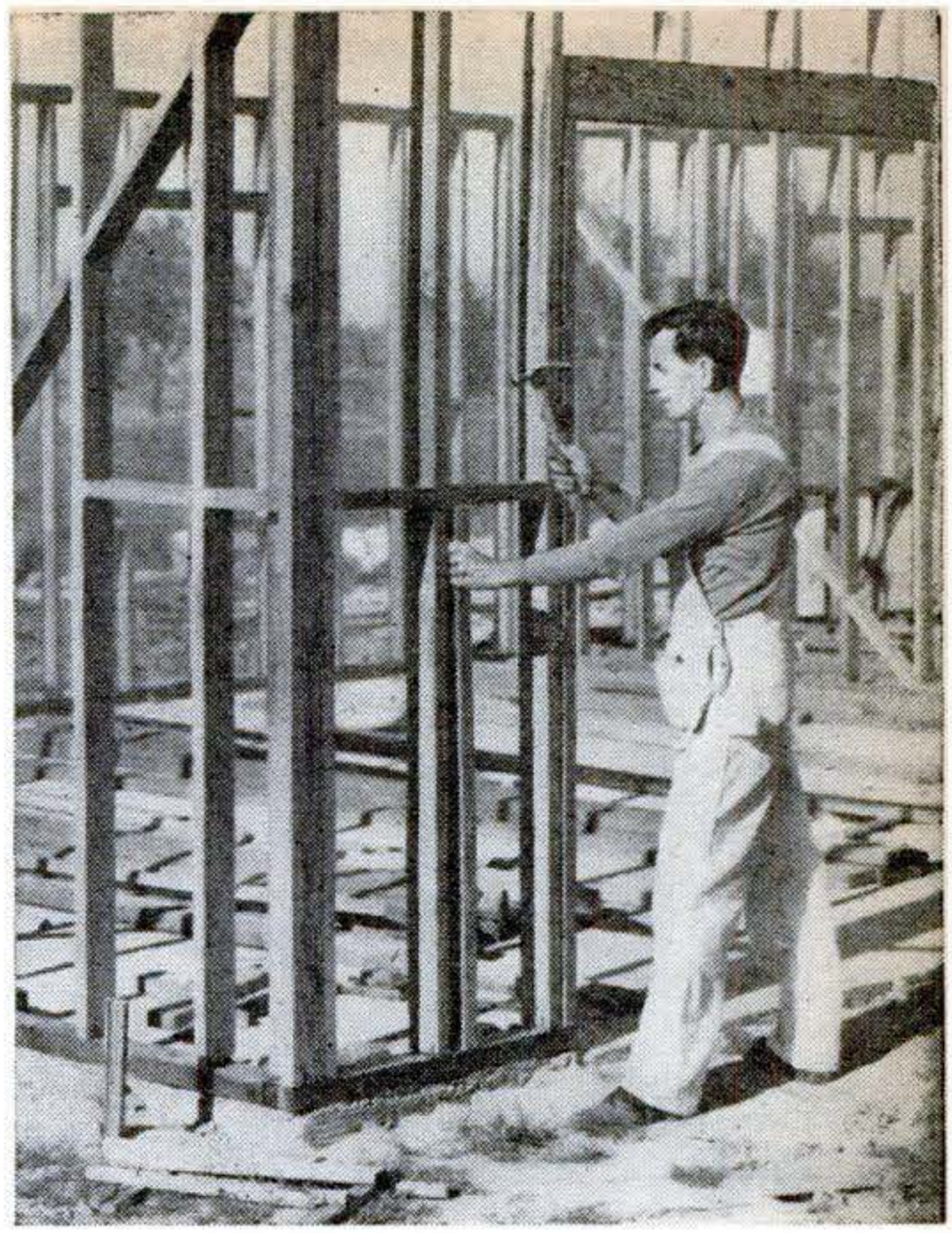


A piece of two-by-four nailed to the studs is a handy support for sawing the ends of brace blocks.



Fire stops are needed even in braced corners. A gauge block prevents slipping during toenailing.

force them in tightly between the headers.

Braces cut from two-by-fours and nailed between studs do little good unless the joints with the studs are accurate. Strike a chalk line or draw one with a straightedge on the edges of the studs, set a bevel square to the angle of cut, and saw the brace members that fit between adjacent studs. Most of those for a given brace can be cut to equal length with a power saw, but cutting to length by hand takes only a few hours. If a carpenter's pencil is used for marking the ends of the pieces, saw 1/16″ outside the lines to make up for the thickness of the lead. Tack in the whole brace before nailing solidly—a precaution against springing studs.

Local building ordinances specify the amount and kind of bracing. Lacking laws, a good rule is a brace at each corner and one for each 25′ of wall length. Extra braces are needed if large openings such as garage doors are in the walls. Most requirements are illustrated in Figs. 4, 5, 6, and 7.

Some builders brace with 1″ by 4″ scantlings notched flush into the outside edges of studs, as in Fig. 6. For such bracing, square the wall frame as it lies on the floor and mark all studs with the strip to be used. Gauge the notch depth, saw the notch ends, and make two or three other cuts between; then take out the waste with a chisel. Nail the braces in after plumbing the raised frame.

Many building codes require fire stops between studs where the vertical space is 7′ or more. While some 2″ by 4″ brace sections take the place of fire stops, stops should be installed at corners and side trimmers for their bridging effect.

Figure 8 illustrates three methods of nailing in fire stops. The linear transmits thrusts without springing studs, while staggered stops are easily spiked from both ends but are not so stiff. Herringbone stops are fairly easy to nail and, if precut to uniform length, can be used in spite of some irregularity of studding thickness; but if carelessly driven at the ends, they may spring the studs. Fit blocks around notched-in bracing. Leave out stops and 2″ by 4″ brace blocks where large pipes are to be installed, fitting them after the plumbing is in.

Ceiling joists, like studs, are spaced for convenience in lathing, and as a rule are laid across the span of the rafters to keep the walls from spreading. For open ceilings that will not be lathed, as in a shop, they can be spaced from 4′ to 6′ apart and located so the rafters can be nailed against their ends. Nail the ends to one plate; then nail the other ends and cut the joists flush.

Block all partition studs and open corners at top, bottom, and fire-stop levels.

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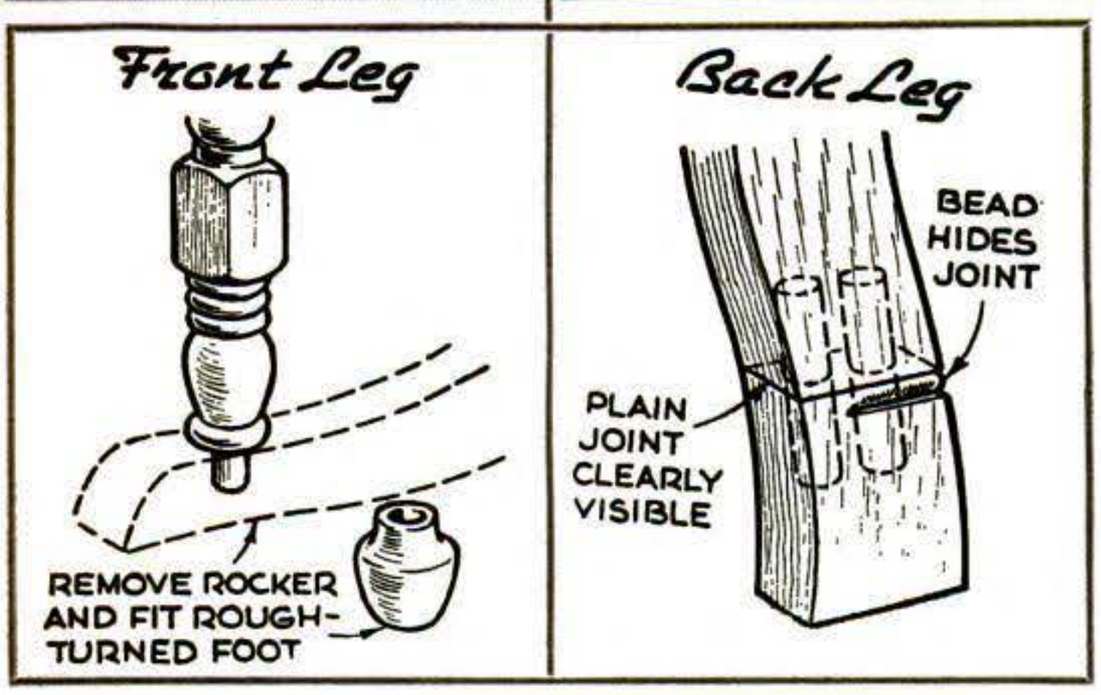
Converting an Old Rocker into a Comfortable Straight Chair

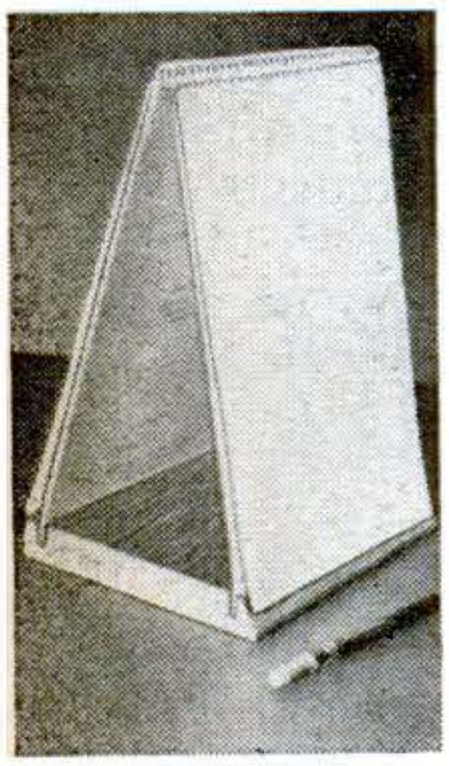


By piecing out the legs, an old-fashioned rocker can be made over easily into a comfortable straight chair. The tenons on the front legs are usually strong and suitable for attaching knoblike feet turned to match other turnings on the chair. Bore the roughly turned feet to fit the tenons; then turn a dowel on the lathe to serve as a mandrel, and force the foot on for finish turning, as in the photo at left above.

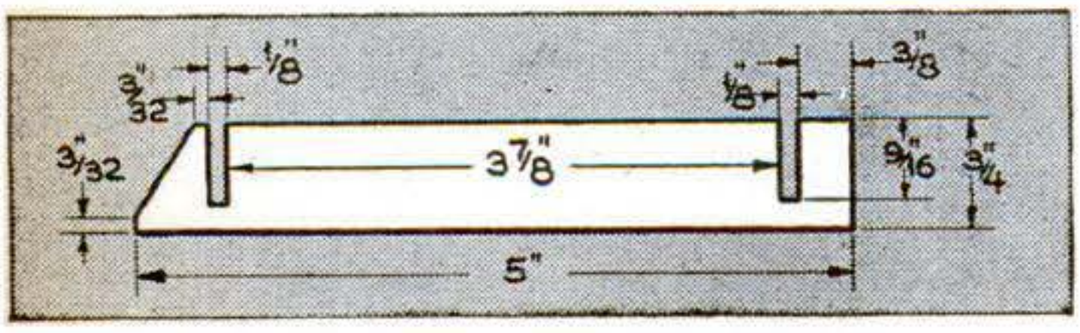
Square the rear legs and attach oversize blocks with dowels. When the glue is dry, work the blocks flush with a plane and cabinet file as in the center photo above. Then stand the chair on a flat surface with the front legs on blocks, set a compass to the thickness of these blocks, and scribe the back legs for sawing to length. A bead may be formed to hide the glued joints.

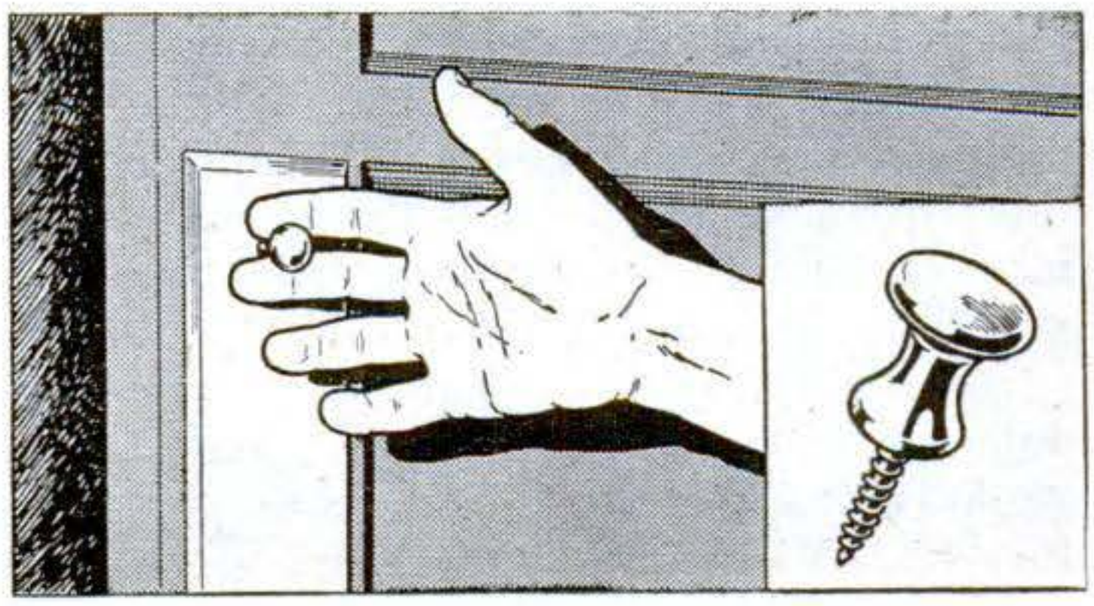
Chamfer the ends of the rear legs, sand all smooth, and finish the new wood to match.—E. M. L.

Grooved Block Holds Notebook



Should a shorthand notebook annoy you by falling flat when it is set up tent fashion for reference when typing, try using a grooved block as a stand. Saw the grooves about 4″ apart in the block. They will keep the book from collapsing. Sand and finish the block to match your desk.—J. C. M.





Pull Improves Swinging Door

When a swinging door needs to be pulled occasionally instead of pushed, it will be easier to do so if a small nickel or plastic screw knob is installed on each side. The upper screw holding the glass push plate may be removed and the knob screwed in its place so it will both hold the plate and serve as a pull.—H. D. Smith.

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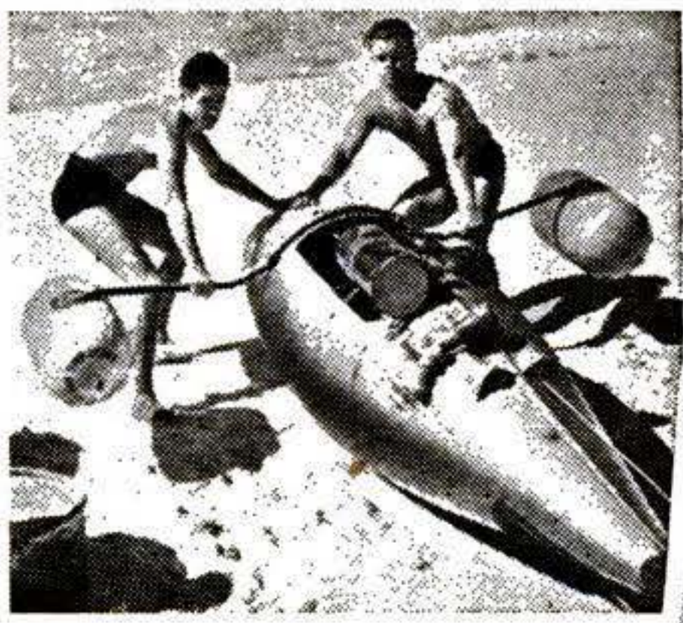
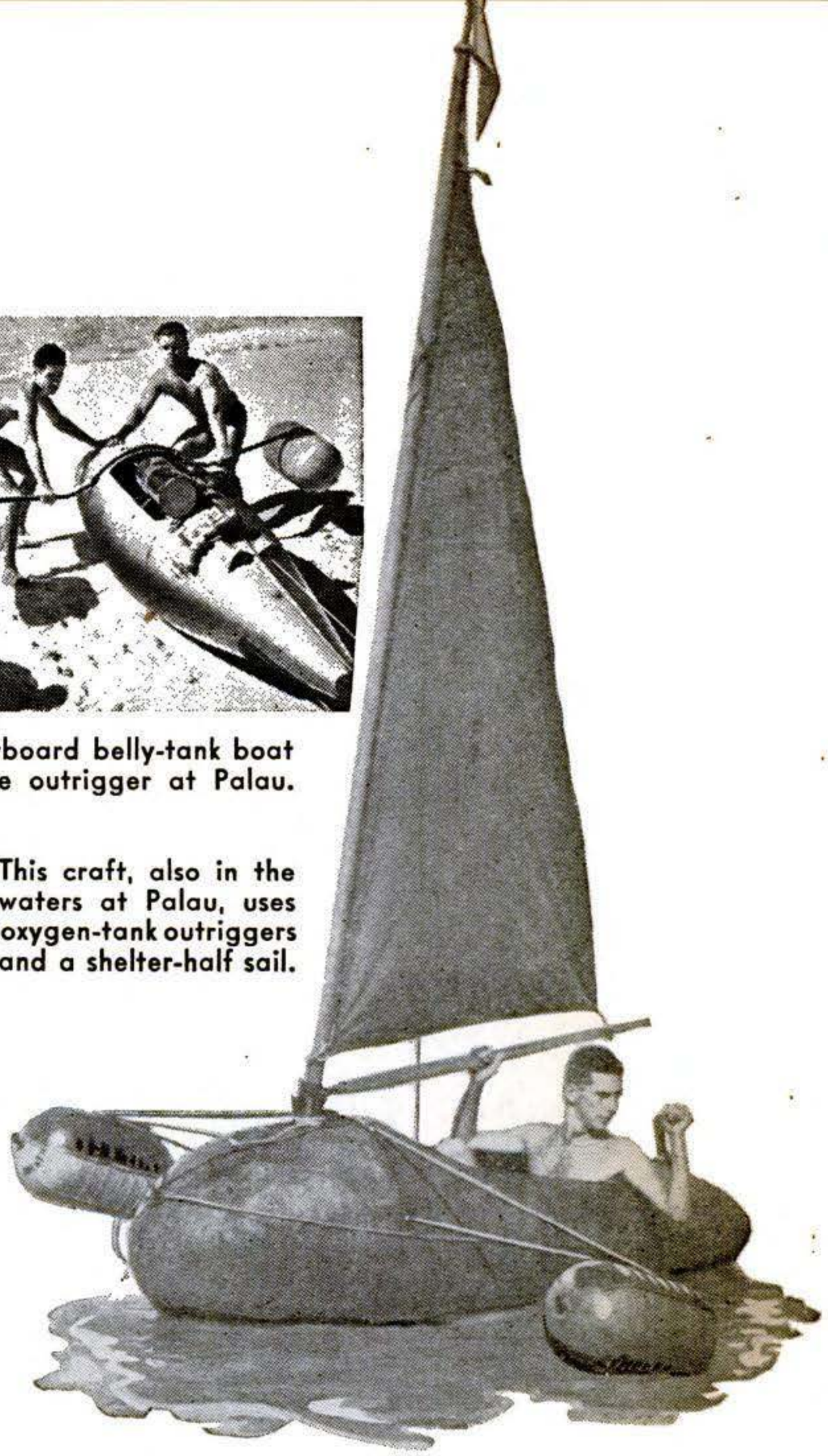
CRAFTSMEN AT WORK

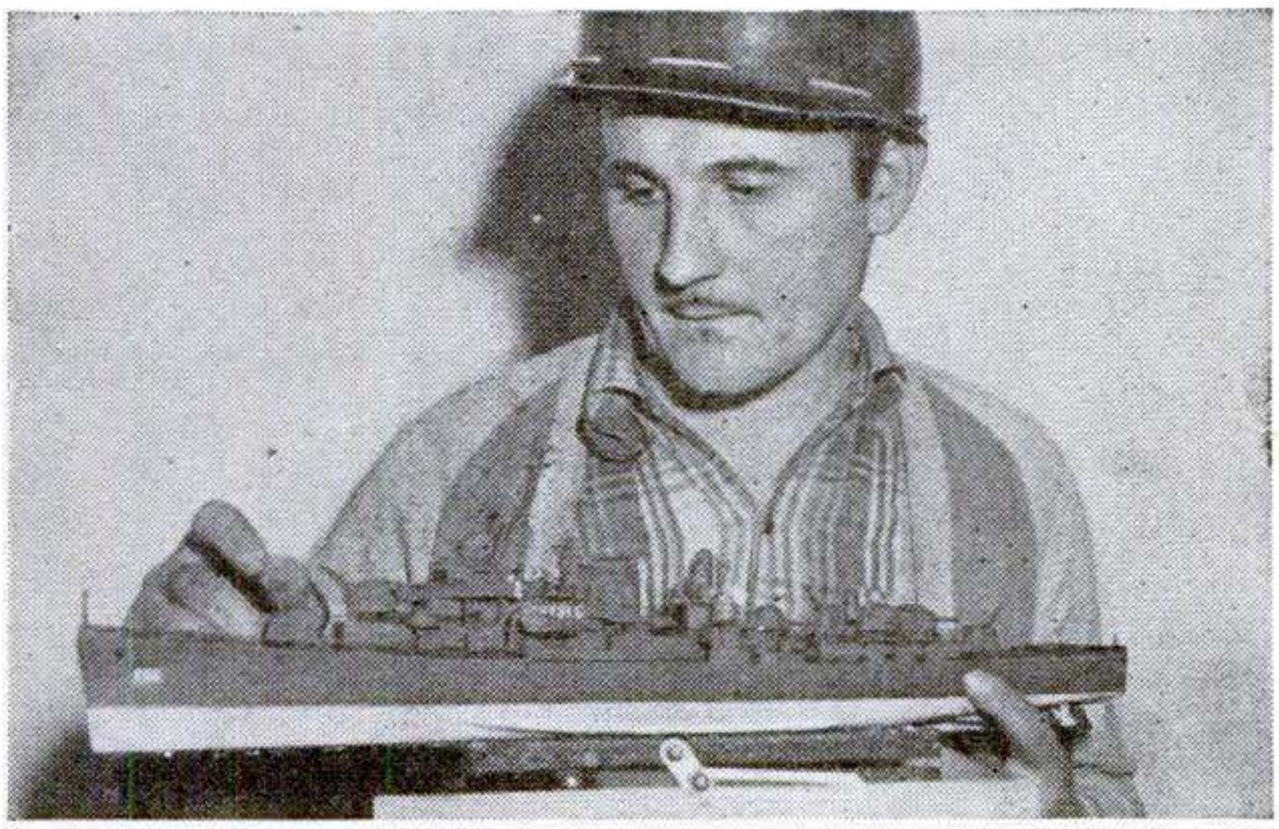


In two oceans with the same idea. At left, an outboard belly-tank boat at Wrightsville Beach, N. C.; right, a gas-engine outrigger at Palau.

TIN-CAN YACHTS built from discarded or surplus warplane fuel tanks have made their appearance from the Caroline Islands in the far Pacific to Wrightsville Beach, N. C. The two outrigger models, with oxygen tanks for the outriggers, were used in the waters around Palau Island by Air Force bomber crews both for pleasure and to get across the lagoon to their base. A shelter half serves as a sail on the boat at right, and the one above it uses a salvaged gas engine. The Wrightsville Beach boat, left above, is made of two belly tanks and is propelled by an outboard motor mounted on a bracket connecting the two tanks.

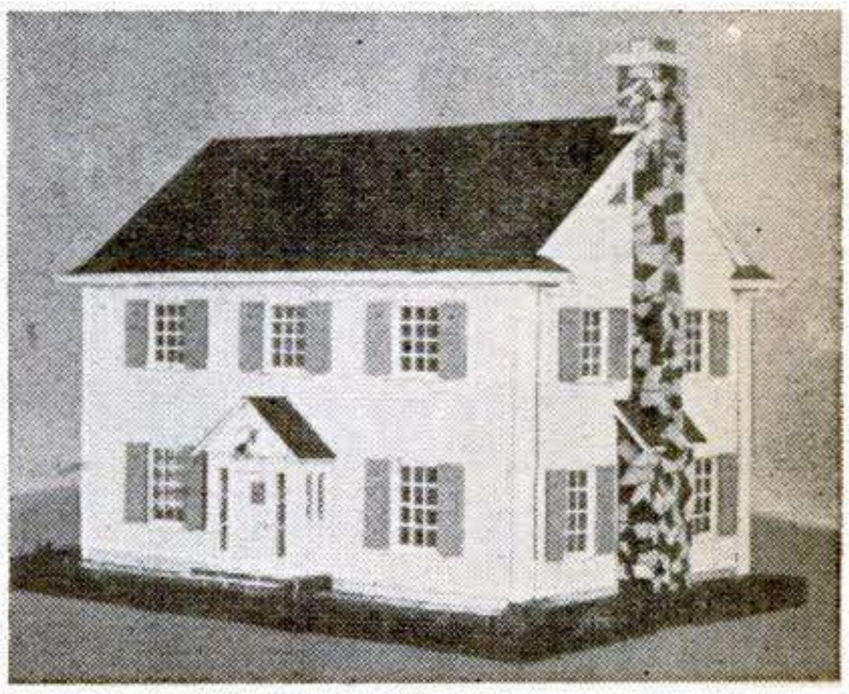


This craft, also in the waters at Palau, uses oxygen-tank outriggers and a shelter-half sail.



WAR SECRET. This model of the destroyer Clarence K. Bronson is so like the real warship that the Navy kept it under lock and key, for security reasons, until the war ended. Stephen I. Dudich, a carpenter, completed the model in his spare time in three and a half months while helping build the actual ship. He used only a pocket knife, sandpaper, and glue.

MODEL HOUSING on a small scale. The 2′ by 2′ 6″ by 3′ project shown below was built by Robert H. Philp, of Grande Prairie, Alta., from ¼″ plywood. It has six furnished rooms, with halls, closets, and bath, and a switchboard with nine light switches. There are 11,000 cardboard shingles on the roof.



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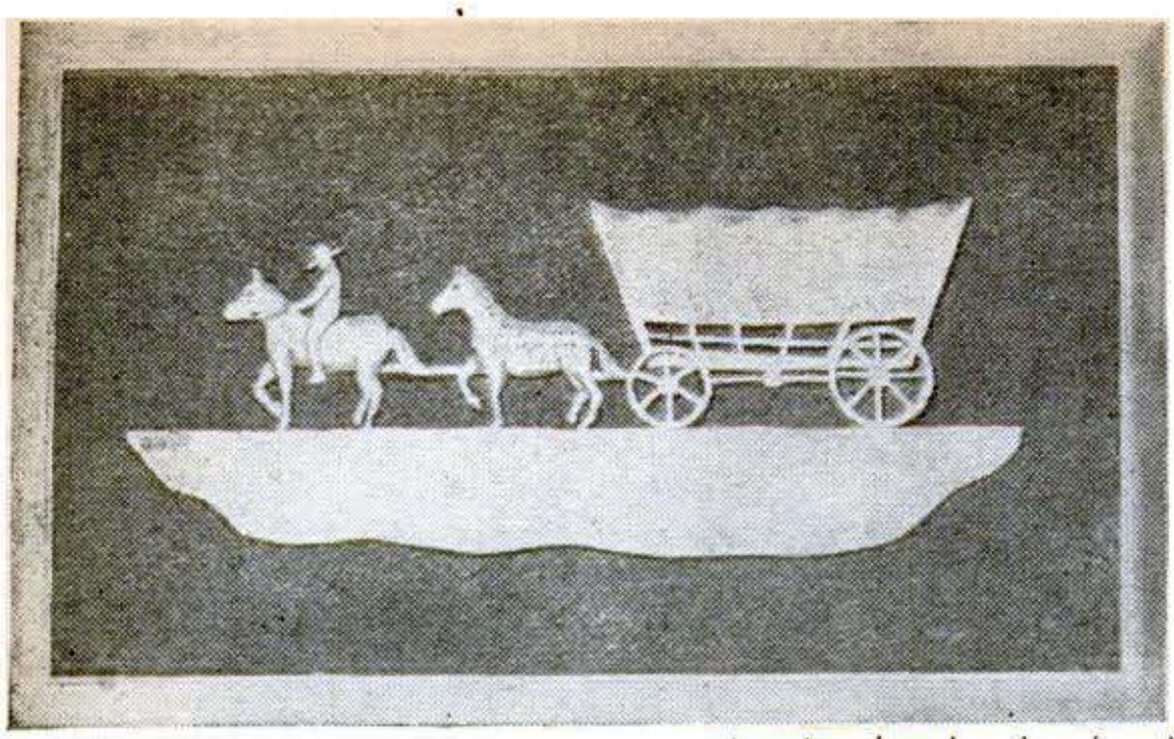
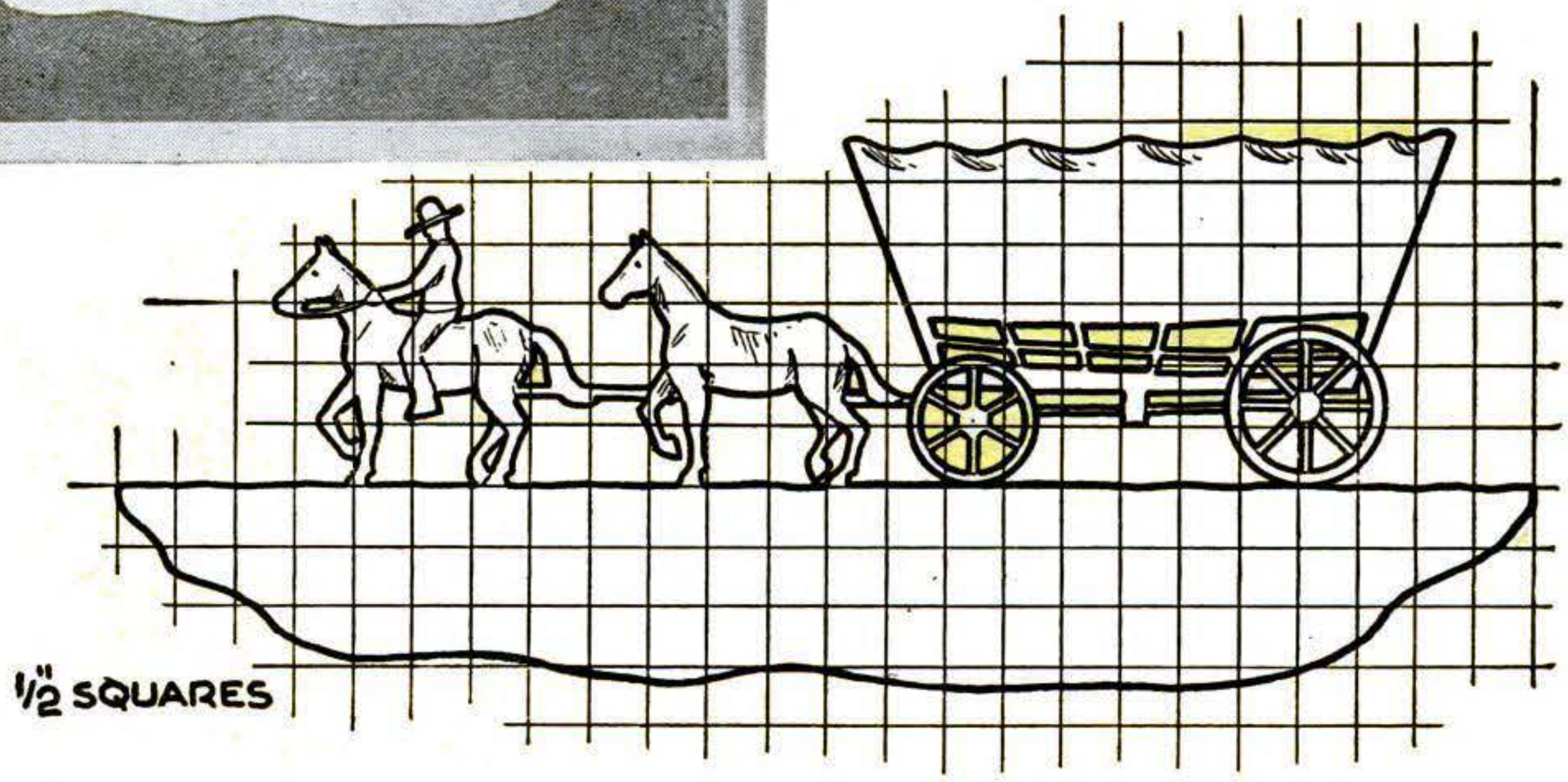
Carved Plaque

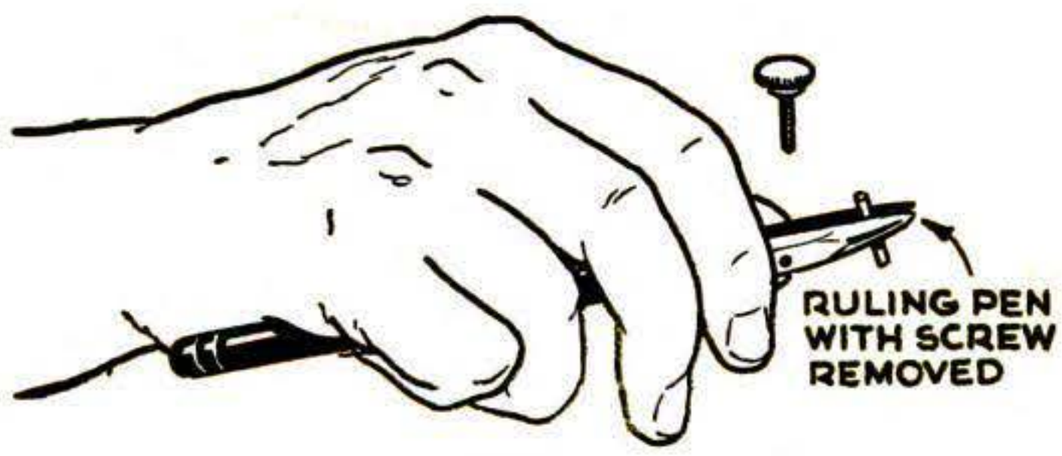




ALL carving on this plaque of a covered wagon was done with a jackknife, though the work could have been speeded with a set of chisels and gouges. Any cutting tool used should be sharp, and it is a good idea to whet it occasionally as the work proceeds. Clear white pine or poplar or whitewood is good; in any event avoid stock with a pronounced grain. Do as much cutting as possible with the grain.

Transfer the pattern full size to kiln-dried 1″ stock dressed to 9″ by 15″. Carve away the background to a depth of ¼″, leaving only the design in relief. Round the edges where required for soft lines, and undercut slightly where sharp, straight lines are called for. Mark off a ½″ to ¾″ border, cut it down ⅛″ below the background, and bevel it smoothly to the edge. A rough-textured background can be achieved by tapping with a punch made from a spike sawed off square at the end and crossed with two hacksaw kerfs at 90 deg.

Sand the design and border and apply three coats of clear lacquer to them, sanding between coats. Then finish the background with a water stain of walnut or other suitable color.—A. D. FACEY.

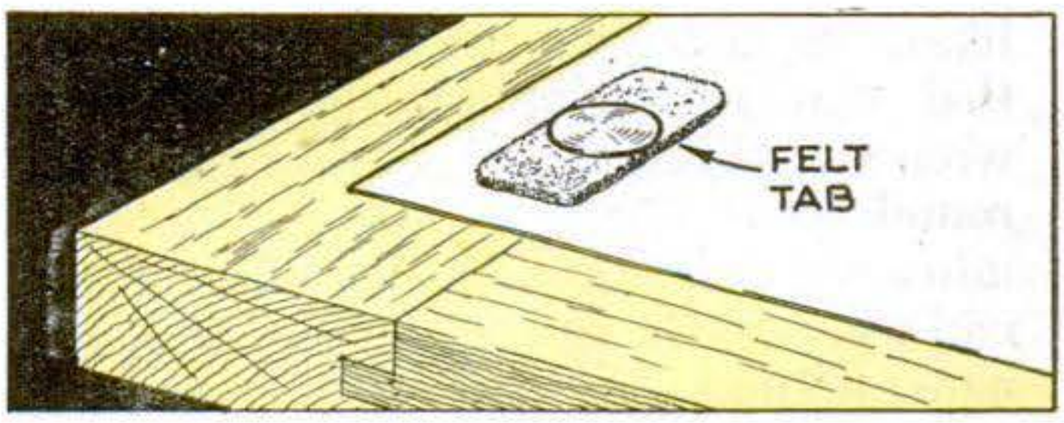


Drawing Pen Used as Tweezers

WHEN tweezers are not available for delicate work, such as repairs on clocks, watches, and cameras, a draftsman's inking pen with the adjustment screw removed will do. Its long handle affords an advantage over most tweezers.—ROBERT SCOTT.

Felt Helps Remove Thumbtacks

USE of felt tabs under thumbtacks, as shown below, facilitates their removal from a drawing or bulletin board. The end of the felt pieces can be gripped readily without danger of breaking a fingernail if the tack resists.—LEO D. KELLER.



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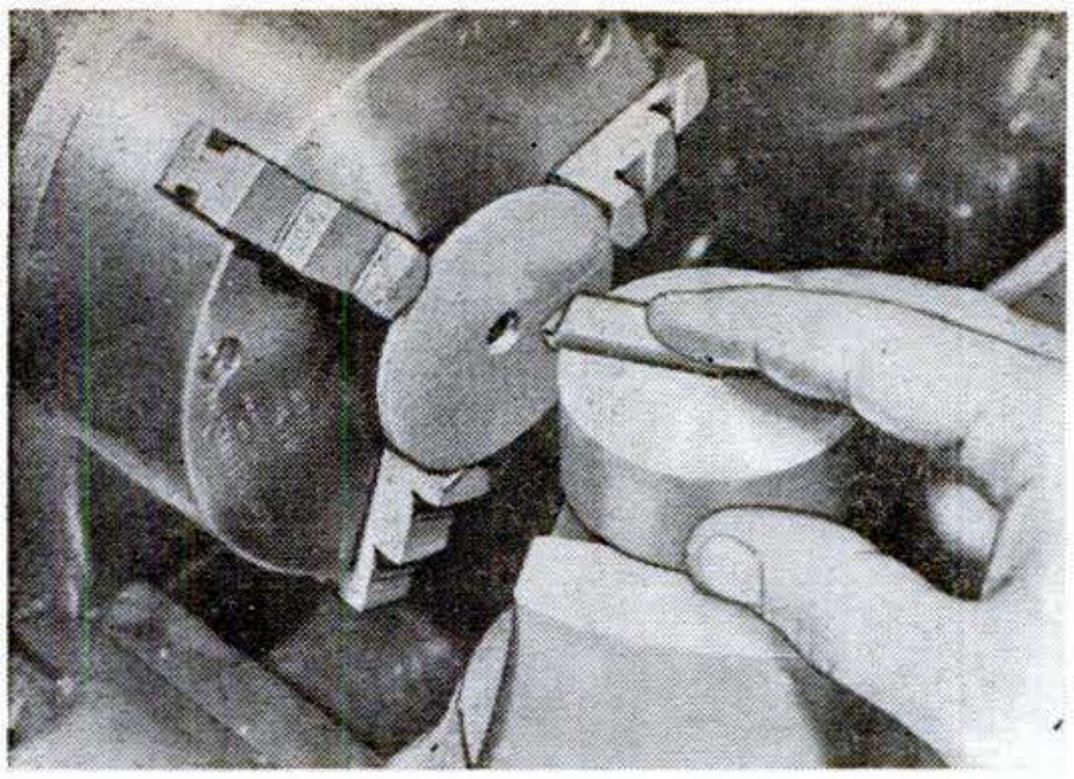
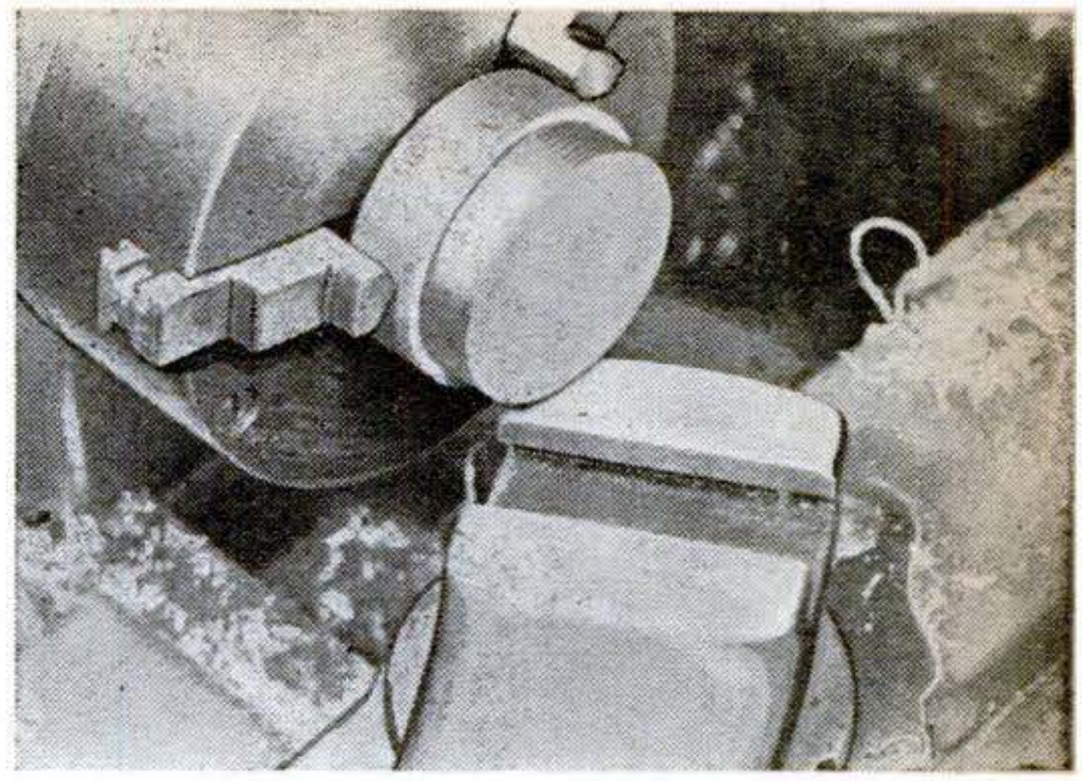
Gauge Block Tailored to Lathe Helps in Scribing Centerlines





SCRIBING a true centerline on the face of a turning can be difficult, but it becomes a very simple and accurate job with the gauge block shown above. Made to suit the lathe on which it is to be used, this block is faced from 2″ diameter steel so that it will reach to the exact center of the lathe spindle when it is placed on top of the tightened-down compound rest. Then a hardened-steel scriber of the type used on height gauges is drawn flat across it to mark the turning, as in the photo at left above, where a bored disk is being scribed for drilling more holes on a radius.

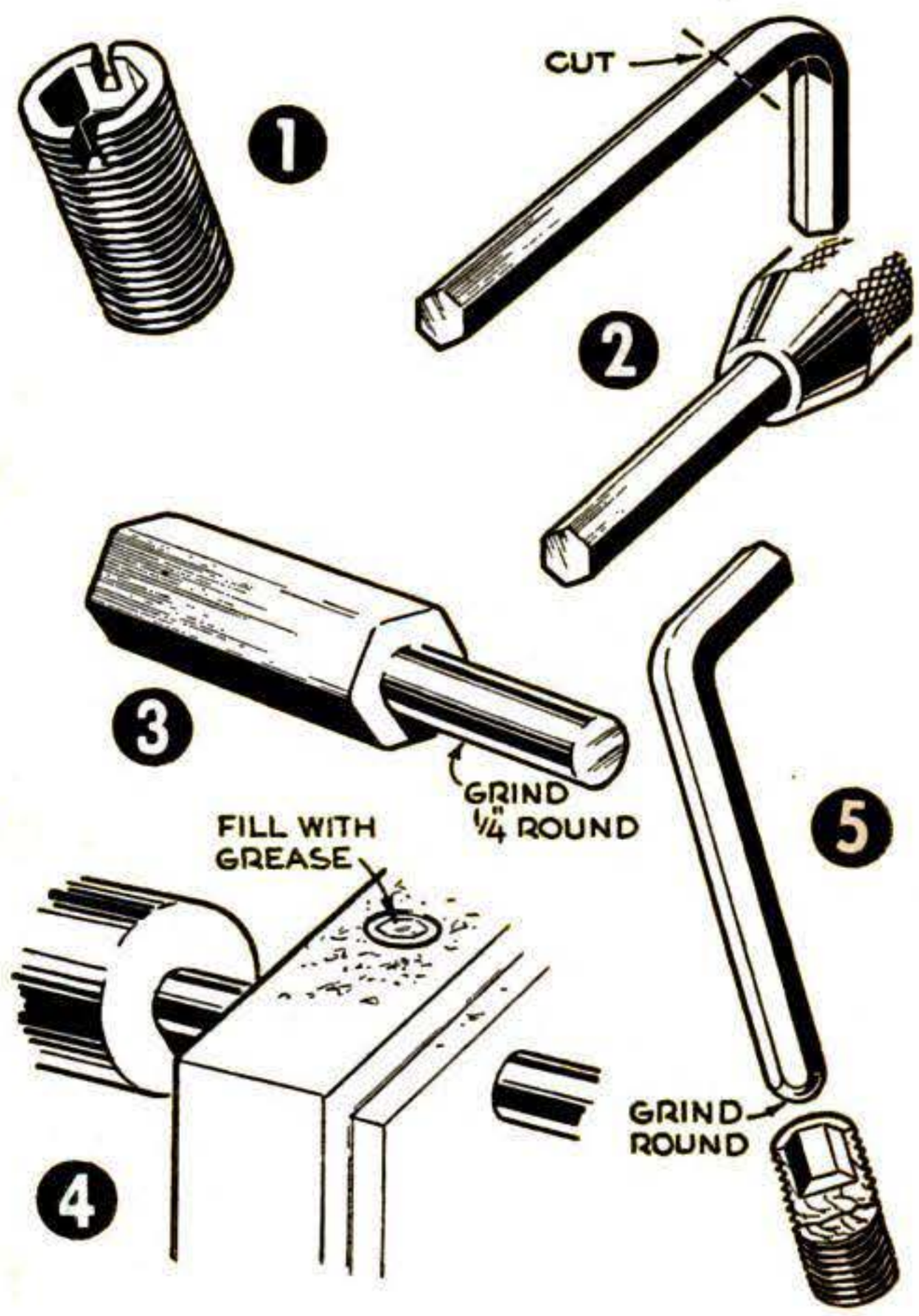
One method of determining the proper thickness of the height block is shown in the photo at right. A piece of scrap stock is chucked and turned down until the top of the compound rest will just slide under it and still leave no clearance. The diameter of the turned piece is then measured with a micrometer, and the reading is divided in half. This result is the thickness to which the gauge block must be faced.—J. C. M.

Five Simple Kinks Speed Up Work with Hollow-Head Screws

FREQUENTLY owners of home and shop mechanical devices are balked in attempts to make minor repairs simply because some part is held by hollow-head screws and there is no wrench at hand to fit. Provided you can borrow a wrench or get the screws out by some other means, they can be slotted with a hacksaw, as in Fig. 1, for future removal with a screwdriver.

If you own one or more bent hexagonal wrenches and find work with them slow, try cutting off the short leg (Fig. 2) and using the straight shank in a bit brace, ratchet box wrench, or breast drill. Wrenches more than ½″ in diameter may be ground round or turned, as shown in Fig. 3, to fit a ½″ or ¼″ chuck in a brace or breast drill.

Stiff grease put in the hollow heads of screws (Fig. 4) will keep grit, dust, and the like from collecting, except in a thin layer that can be penetrated easily with the wrench. Grinding the end of a wrench round, as in Fig. 5, will help in getting it into a socket that can't be seen. The rounded end will pass the square shoulders and eliminate fumbling.—JOHN KRILL.



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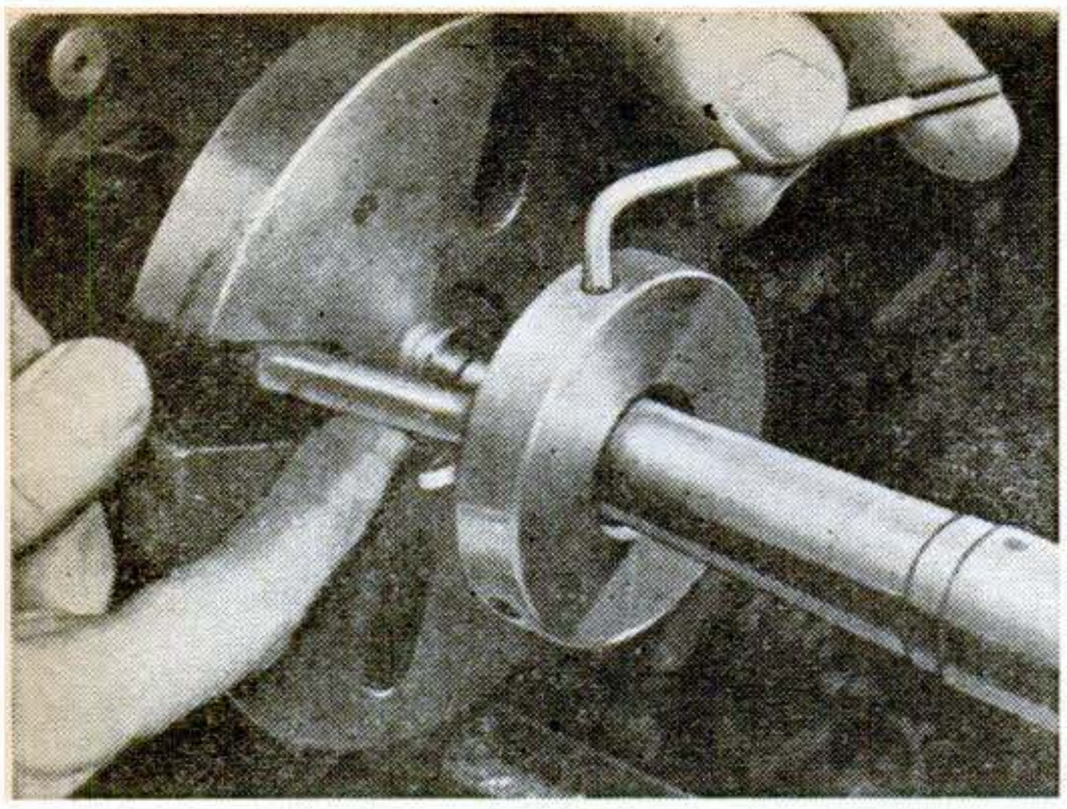
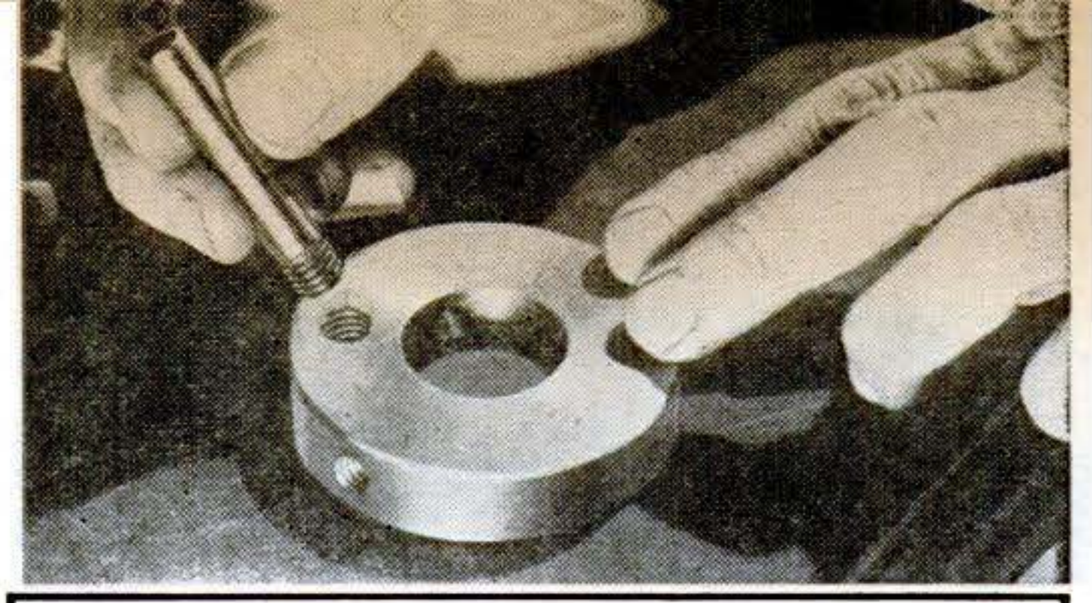
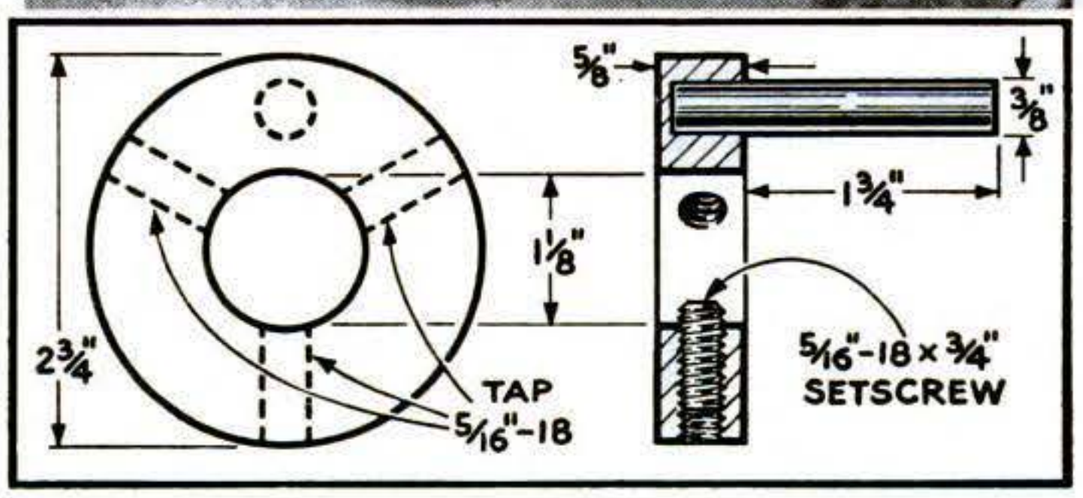
NEW SHOP IDEAS





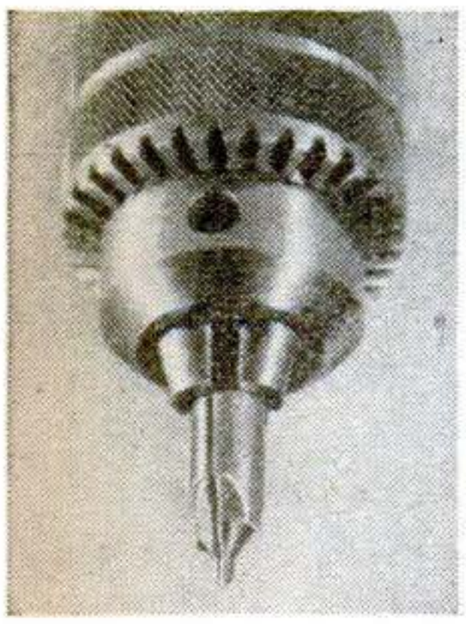


LATHE DOGS CAN'T BITE if they have no exposed screw heads or other projections to catch fingers or clothing. This one, designed to take work from ⅛" to nearly 1⅛" in diameter, is turned and bored from cold-rolled steel to the dimensions shown.

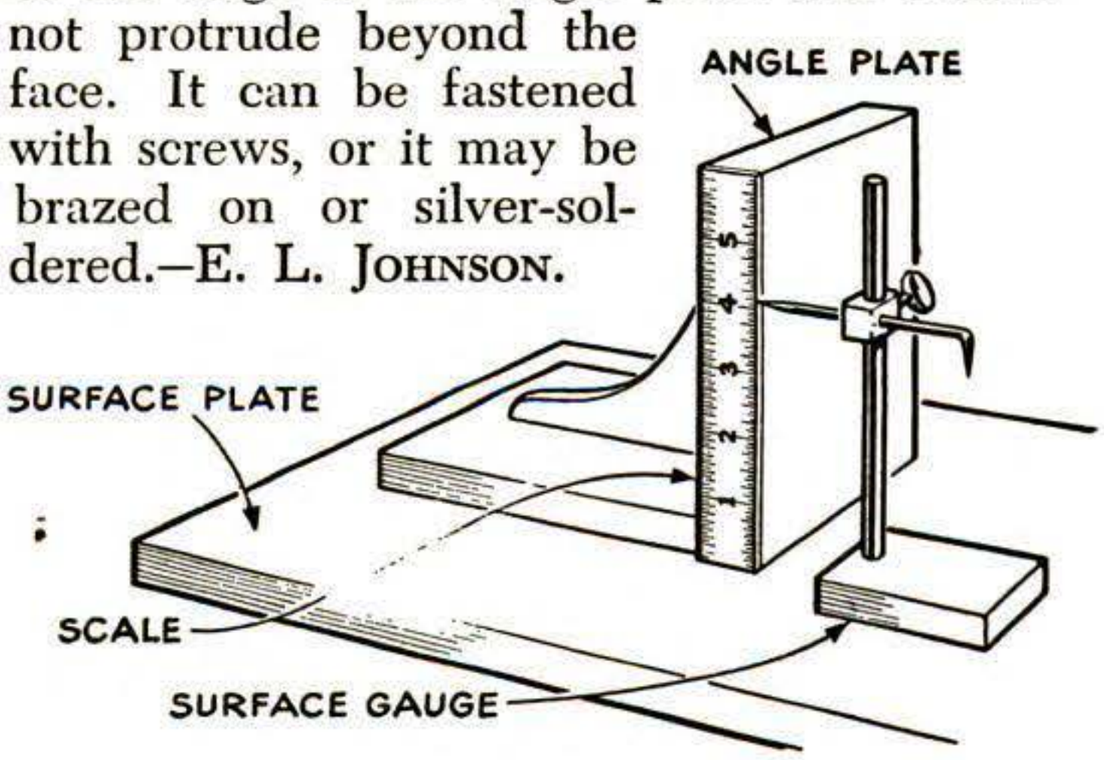
Three radial holes are drilled with a 17/64" bit and tapped for 5/16"-18 hollow-head setscrews ¾" long. The pin may be a ⅜" headless bolt threaded in, or it may be a drive fit or welded or brazed. If necessary, it can be bent outward or its hole drilled at an angle to engage the slot.

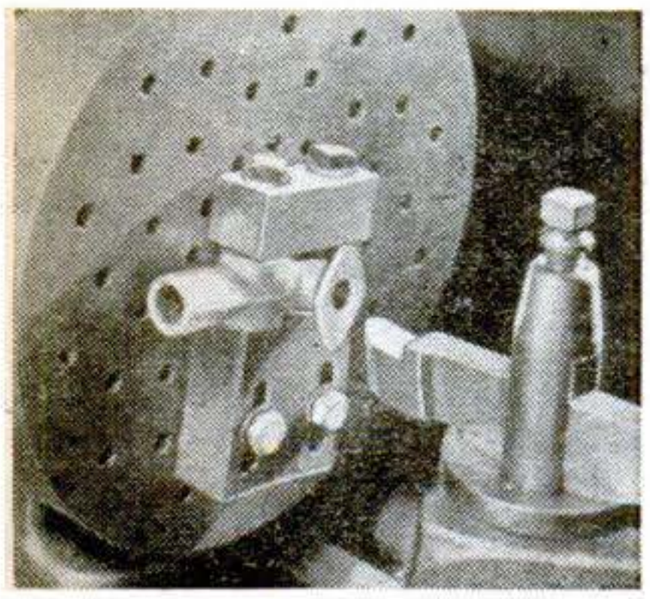
A 7/16" by 1½" o.d. dog with a ½" center hole and ¼"-20 by ½" setscrews will take work under ½" diameter. One ¾" by 5" with 2" i.d. and ½"-13 by 1½" screws is suitable for 1" to 2" work.—W. E. B.

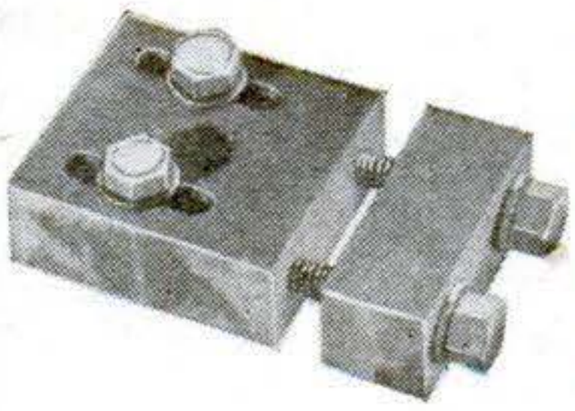
CENTER-HOLE DEPTH, which must be uniform in duplicate taper work, is readily gauged with the attachment shown here. It's also useful for making countersunk screw holes. The gauge is made up from a short length of brass tubing with the ends partly cut away for chip clearance. It is split down one side and slipped over the center drill, gripping it snugly. The collar is not chucked, but bears against the jaws and therefore affords a positive stop.—C. W. W.



A SCALE ON AN ANGLE PLATE, shown below, will save considerable time and be an aid to accuracy in layout and setup work. The scale is attached as a permanent fixture to the edge of the angle plate and should not protrude beyond the face. It can be fastened with screws, or it may be brazed on or silver-soldered.—E. L. JOHNSON.







THIS FACEPLATE VISE is designed to hold hard-to-chuck parts in the lathe and is a help also in mounting small parts firmly and accurately on a drill pad. It is made up of two small blocks of steel and four bolts, as shown. The smaller of the blocks is tightened up on the work to serve as a clamp.—C. W. W.

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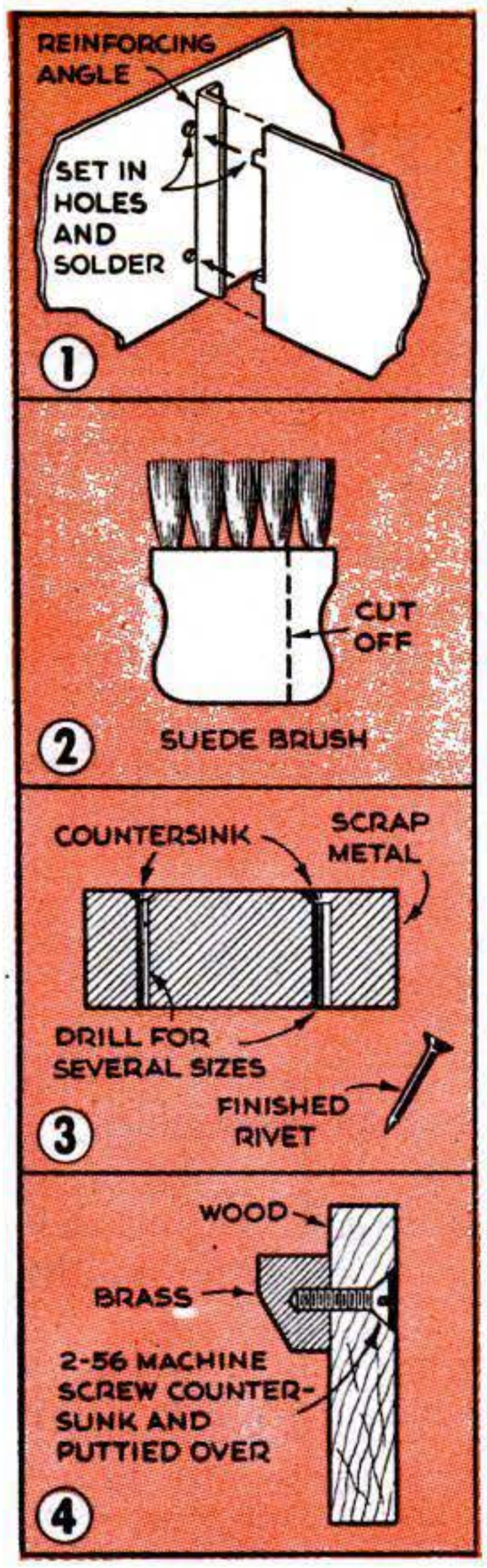
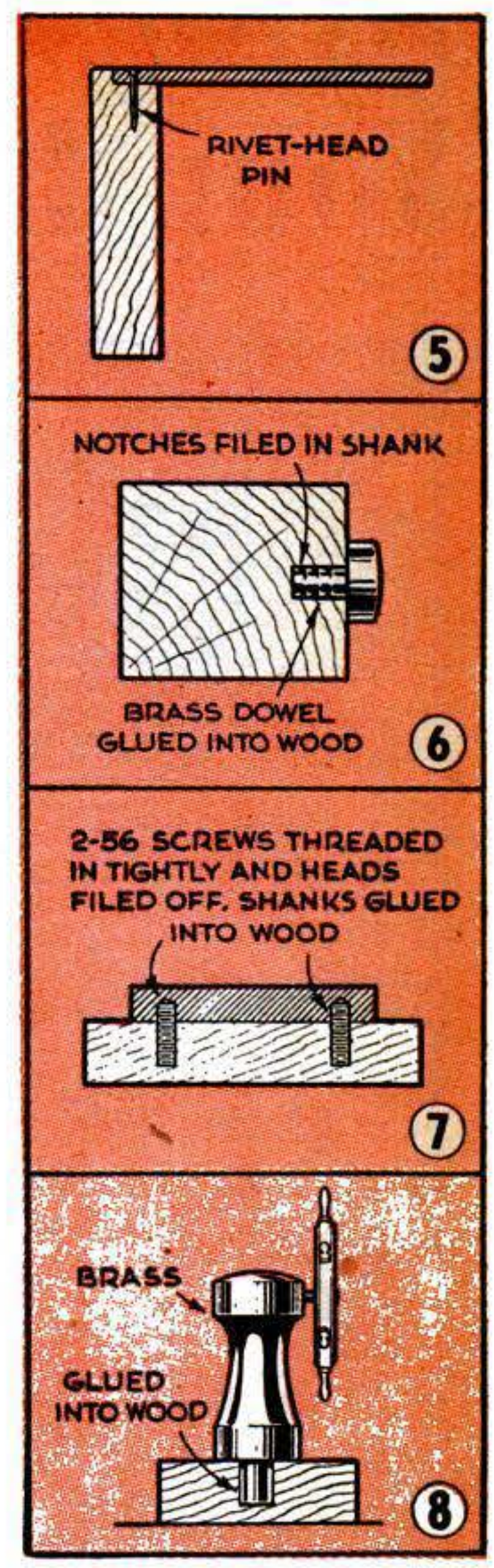


How to Obtain Strong Joints in Model Construction



If your carefully finished models are fragile and won't bear handling, try these means of adding ruggedness as well as realism to your next project.

Where metal joints must support any strain, soldering alone is undependable. A right-angle joint between two plates, for example, can be strengthened by filing lugs on one piece and soldering them into matching holes in the other plate (Fig. 1). A small angle adds reinforcement.

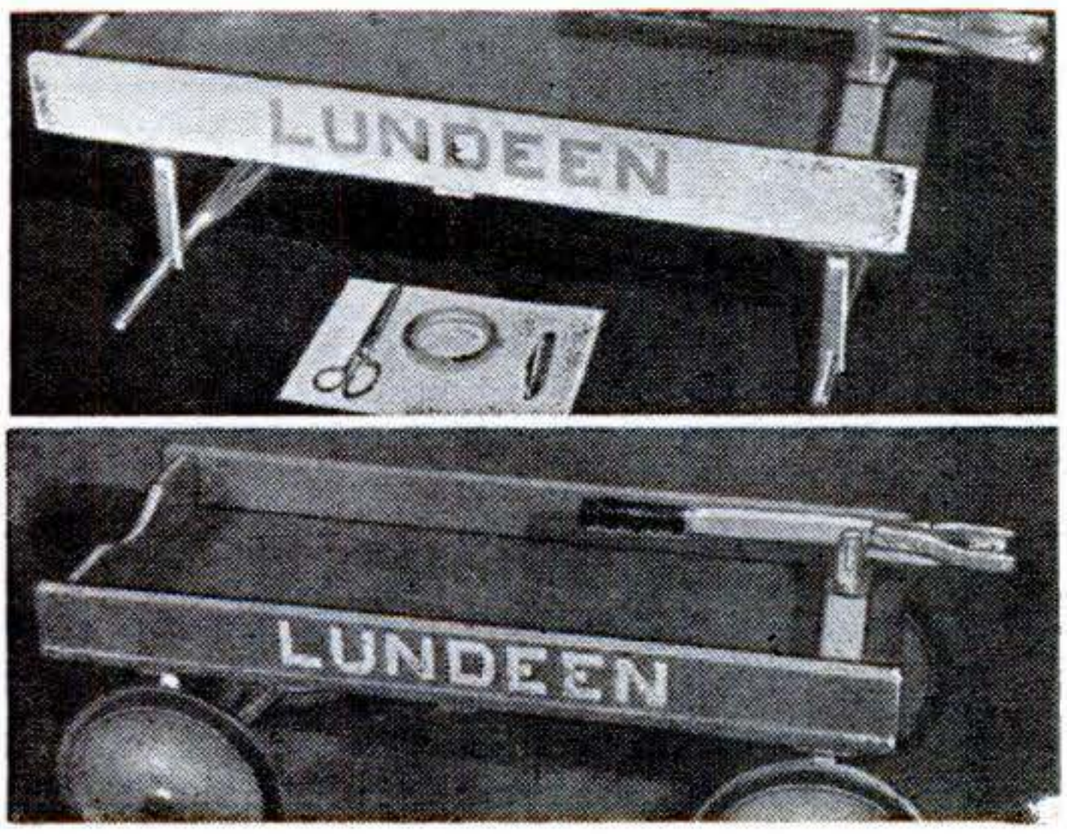
For a neat finish, all excess solder must be removed. Use a brush made by cutting one row of bristles off a suede brush (Fig. 2) to sweep away extra solder while still hot. Chisels ground from old files will remove lumps, clean out corners, and produce sharp offsets, while fine sandpaper and steel wool add the final touch.

Flush rivets can be made from escutcheon pins by hammering the heads flat in a steel block (Fig. 3). Figures 4, 5, 6, and 7 show several methods of providing strong, clean-looking brass-to-wood joints.

To attach turned parts neatly, turn a dowel pin on the piece itself, as illustrated in Fig. 8.—Herbert Pfister.

Tape Stencil for Lettering

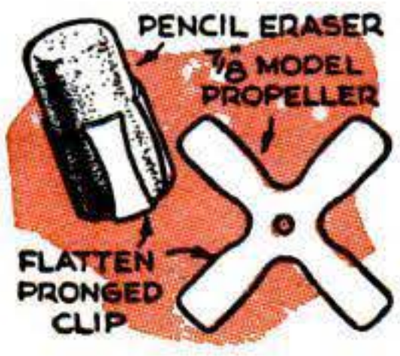
With masking tape, even those incapable of finicky brushwork can do neat lettering. The surface is first given an undercoat lighter than the finishing color. Then letters are formed from strips of ½" draftsman's masking tape, and the top coat applied over the tape. When the paint is dry, the tape can be pulled off, revealing the lettering in the undercoat color.—George T. Lundeen.



Tubes Supply Miniature Grilles

Burned-out radio tubes are a good source of radiator grilles for model racing cars. Many tubes have nickel-plated screens and grids which on a scale model look like the real thing. Carefully break the glass envelope near the base to secure the screens without damaging them.—R. Fraser.

Small Propellers for Models



To make miniature propellers for model airplanes or ships, press out flat the metal mounts of the erasers used in automatic pencils.—K. M.

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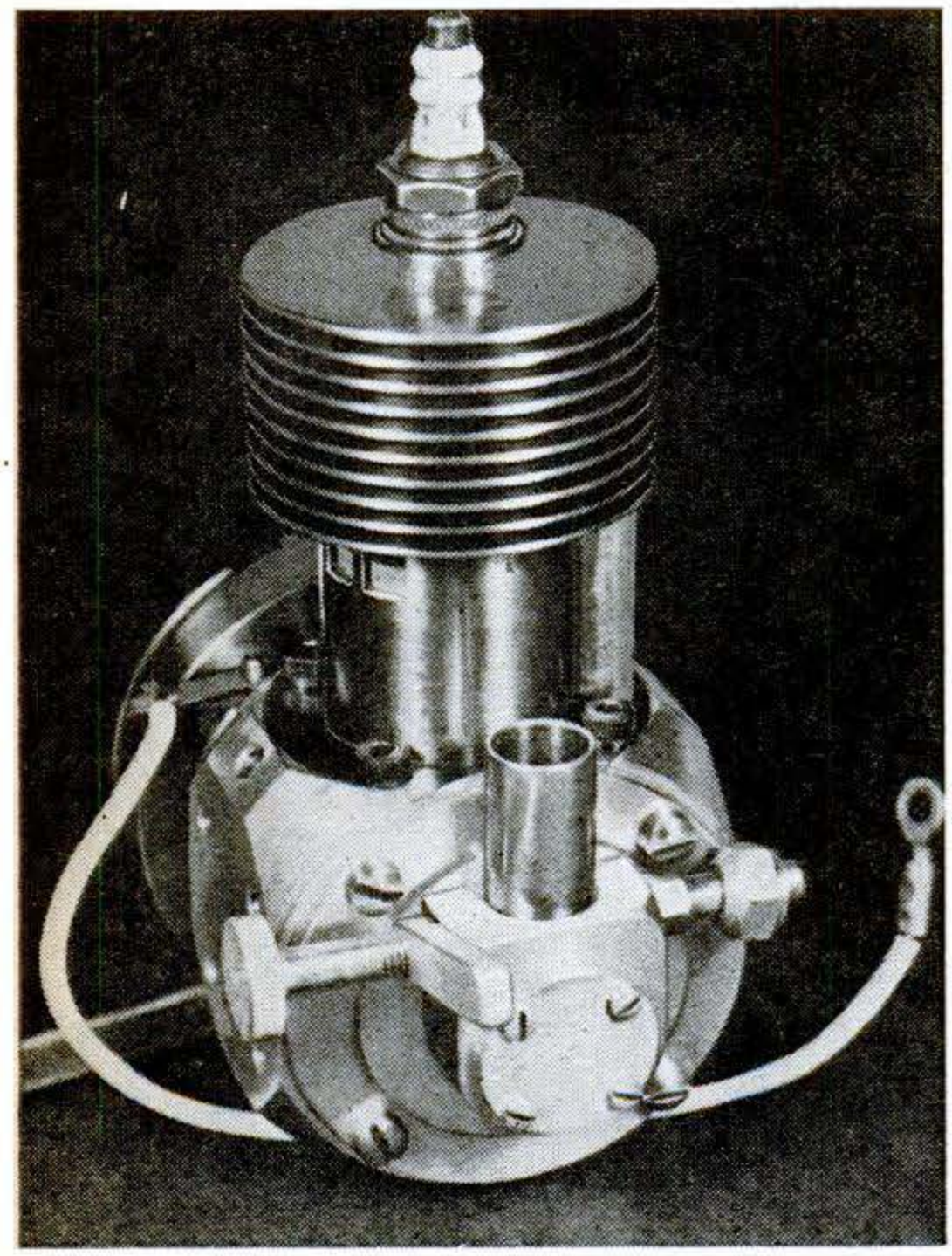
FINISHING and STARTING UP

Your High-Speed Gas Engine



PART III

By J. C. MAGEE

NOW approaches the big moment for you to cash in on your work in building the 13,000-r.p.m. model gas engine. Those who couldn't wait for the complete story have already finished the crankcase (P.S.M., June '46, p. 146) and the cylinder, piston, and connecting rod (P.S.M., July '46, p. 176). There remain only the crankshaft, timer, and needle valve. Then you will be ready to assemble the engine for its first tryout.

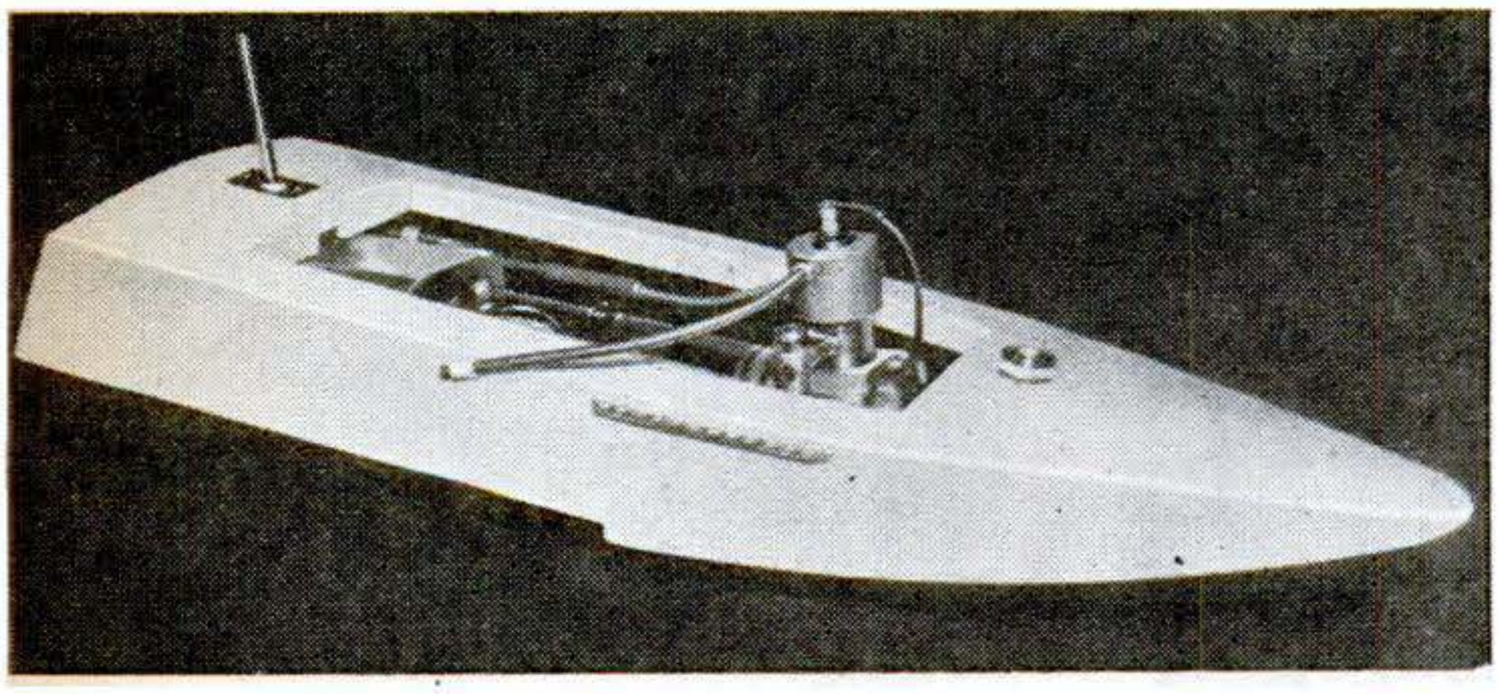
Use only a good grade of machine steel for the crankshaft. Face it to finished length so you can work from either end. Hold the shaft and flange diameters close to size for a snug fit in the crankshaft fixture shown on page 179.

To mount the fixture off center, first chuck a piece of scrap and turn it to a 2.500″ diameter. Then clamp an indicator in the tool post touching the 2.500″ diameter and set it at zero. The fixture and crankshaft are next clamped to the faceplate with the indicator reading zero when it touches the 1.500″ flange. Thin brass in the setscrew holes prevents marring. When the crankpin has been turned to .500″, it should be flush with the 1.500″ diameter. A few thousandths error is not serious.

The depth of the 1.500″ bore of the fixture is .202″ so the flange thickness can be located from the face. If the center hole in the lathe faceplate is smaller than 1 7/16″ in diameter and ½″ in depth, make the fixture 2⅛″ long instead of 1½″. Clamp a stop on both sides of the lathe carriage to restrict the tool travel to .375″.

Make the crankpin slightly oversize and polish down with fine emery and crocus cloth for a good bearing surface. File the flange cutouts carefully to get balance, but do not form the chamfers yet.

To insure an absolutely true center for finish-turning (step 9), chuck a piece of rod, turn a 60-deg. point, and use this as a live center. Then the work can be turned end for end without worry. Make the .375″ and



WATER COOLS the engine used in this model boat. The water intake is directly behind the propeller in the shaft strut, assuring an adequate supply when the engine is running with the boat stationary. Either an air- or water-cooled cylinder can be used on the model described on these pages.

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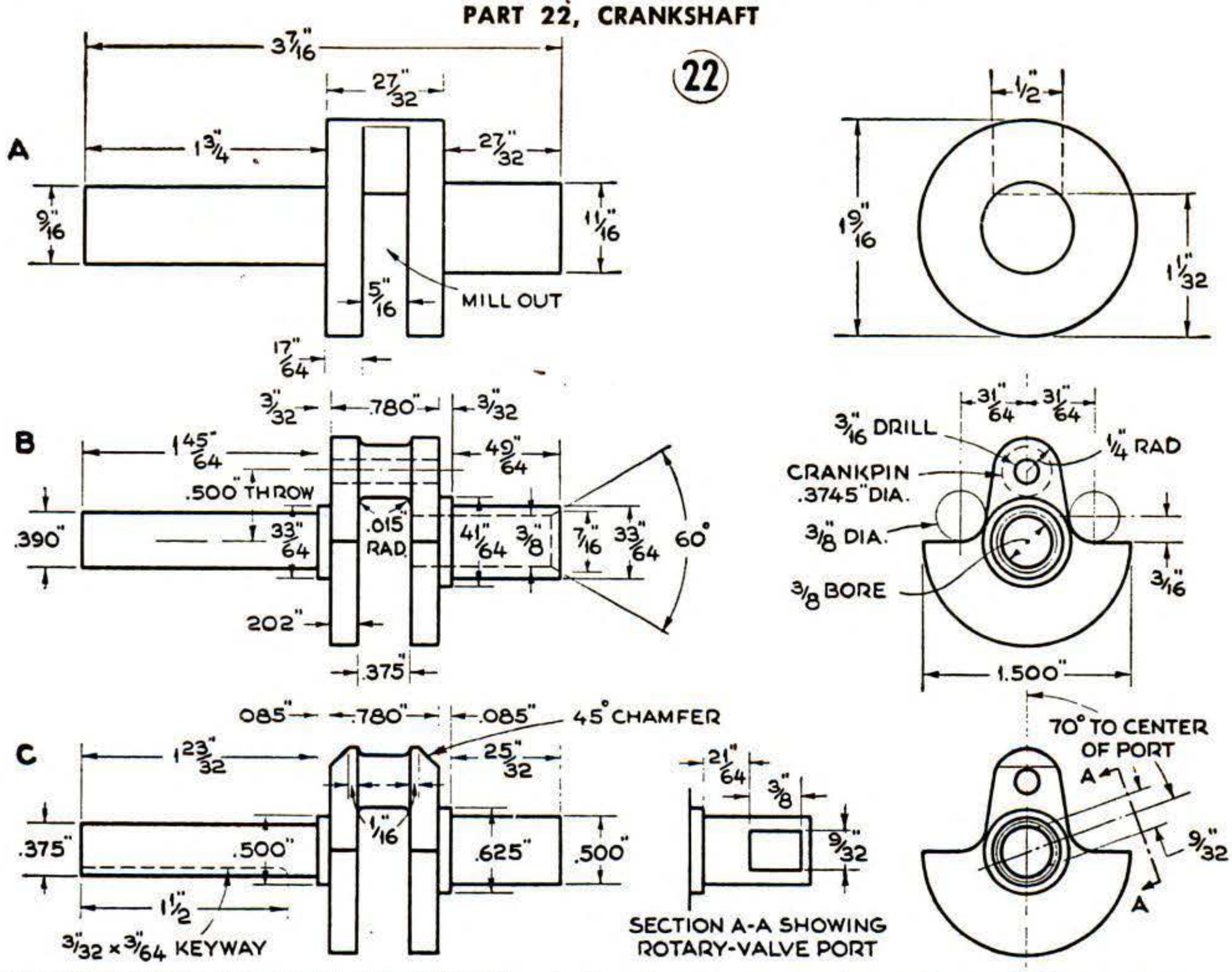
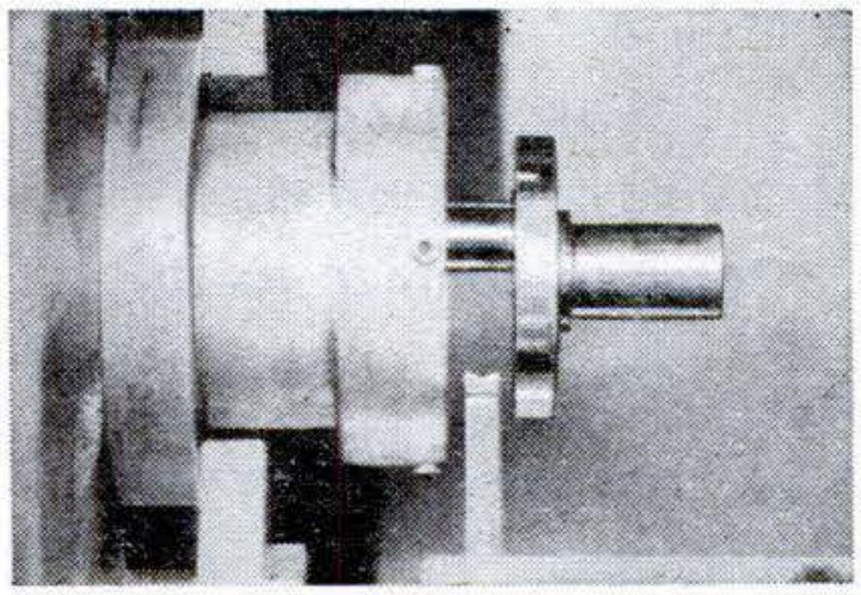
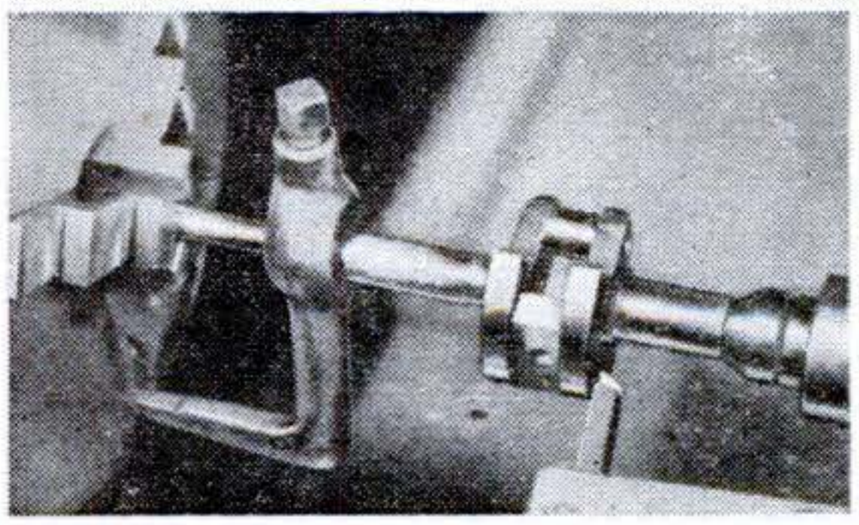
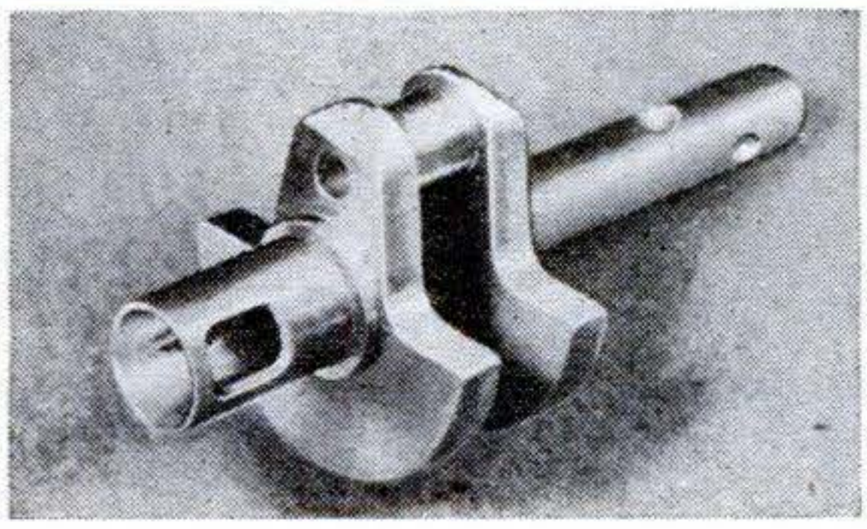
WORKSHEET NUMBER EIGHT

PART 22, CRANKSHAFT









1. Rough-turn, as at *A*, to the 3 7/16″ finished length.

2. Mill out the flange with a 5/16″ cutter to a depth of 1 1/32″, leaving a ½″ width for the crankpin.

3. Chuck the short end true and center the other end.

4. Rechuck on the long end, bore the short end ⅜″, as at *B*, and bore a 60-deg. chamfer to serve as a center.

5. Mount between centers, turn the shaft, as shown at *B*, and face the flanges to the finished .780″ dimension.

6. Mount in the fixture shown on page 179, finish-face .375″ between flanges, as in the photo at top left, turn and polish the crankpin, and drill the pin 3/16″.

7. Lay out the counterbalances as in the end view.

8. Drill two ⅜″ holes, saw out the remaining material, and finish-file to shape.

9. Mount a small .375″ block with rubber cement between flanges opposite the crankpin to support the shaft while it is being turned between centers, as shown in the middle photo.

10. Finish-turn on centers to the dimensions at *C*.

11. Mill the keyway on the side opposite the crankpin.

12. Lay out the rotary-valve hole (section *A-A* at *C*), and drill and file to size.

13. Remove all burrs.

Note: Do not machine or file the two 45-deg. chamfers now; they are for balancing later. The completed crankshaft is shown in the lower photo.

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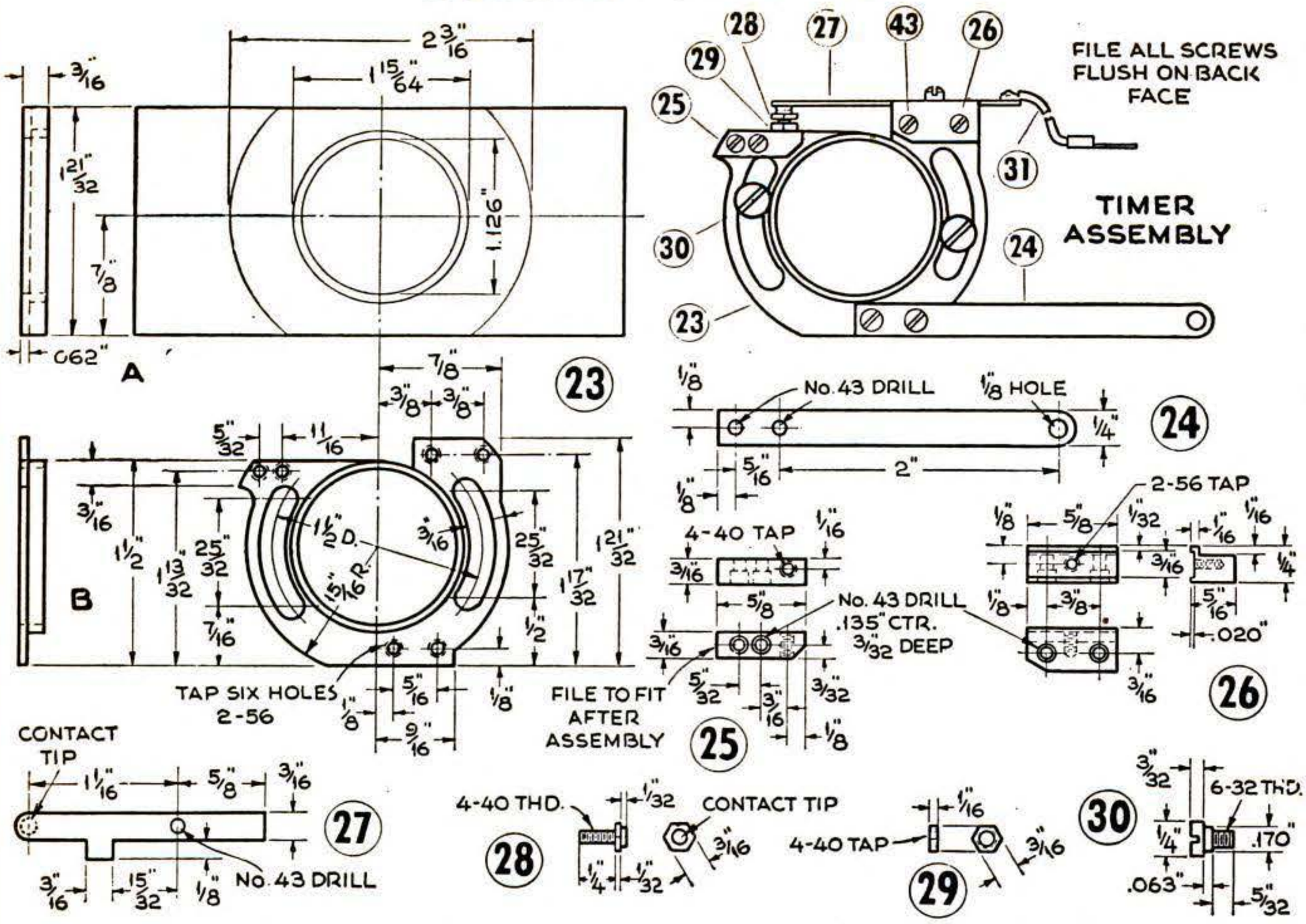
WORKSHEET NUMBER NINE



PART 23, TIMER BRACKET

1. Mill to a width of 1 21/32″.

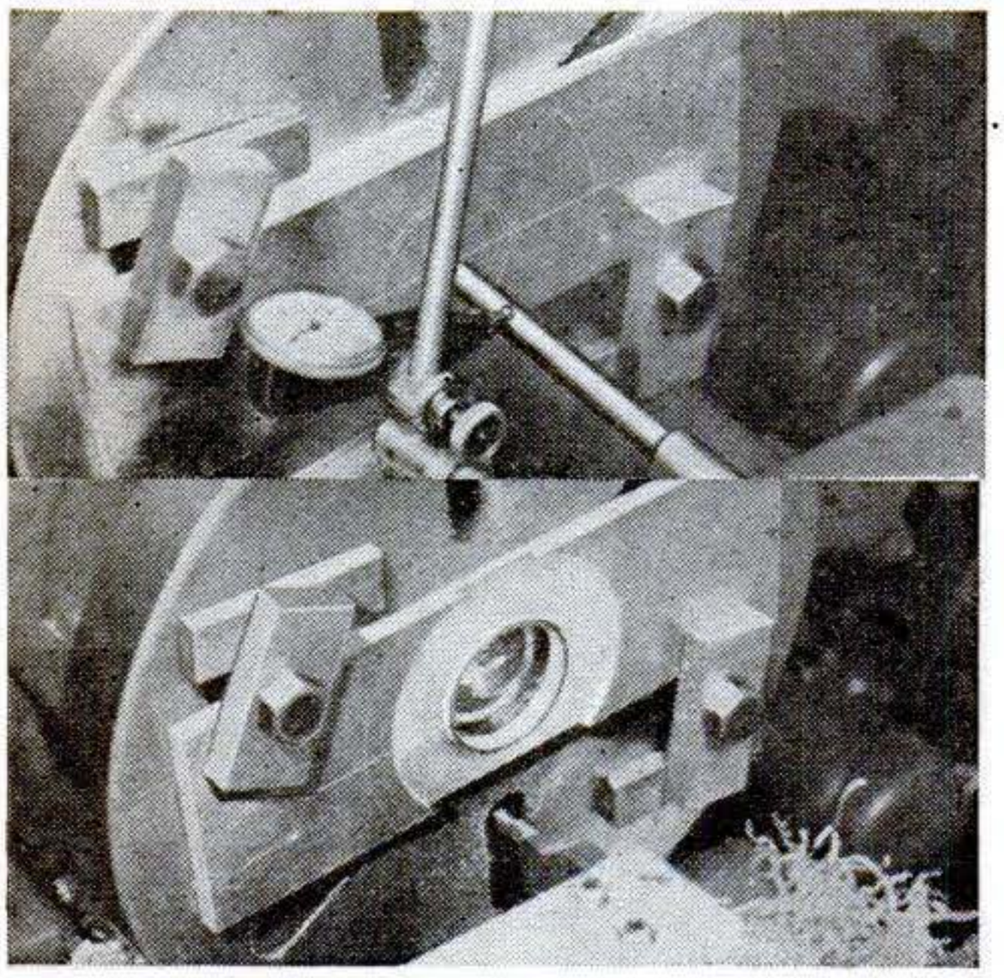
2. Lay out the 7/8″ line, center on the faceplate, as in the photo directly below, and turn, as at *A* and in the second photo below.

3. Lay out complete, as at *B* and in the photo at right. Drill and tap, and drill 3/16″ holes at the ends of the two slots.

4. Mill or file the slots, and saw and file the outside contour. Remove all burrs.

PART 24, ARM

1. Lay out, drill, and file to shape.



PART 25, POINT BLOCK

1. Drill, tap, counterbore, cut off, and chamfer.

PART 26, BLOCK

1. Mill to shape, drill, tap, and counterbore.

PART 27, CONTACT ARM

1. Lay out, drill, and file to shape. Solder or rivet the contact tip in place.

PART 28, CONTACT SCREW

1. Turn and thread. Solder contact tip on.

PART 29, LOCK NUT

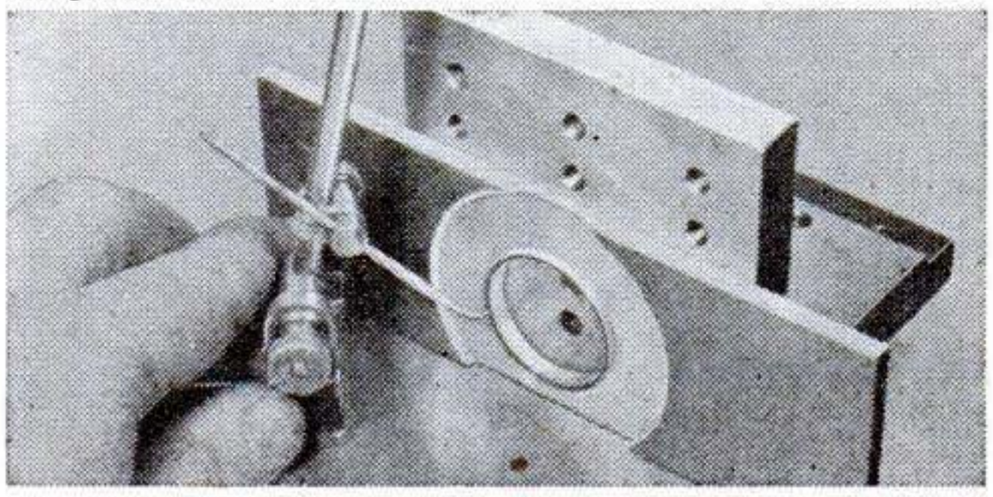
1. Drill, tap, and part off.

PART 30, CLAMP SCREW

1. Turn, thread, part off, mill or saw a slot.

PART 31, LEAD

1. Cut to 6″ length, strip the ends, solder a small terminal to one end, and solder the other end to part 27.



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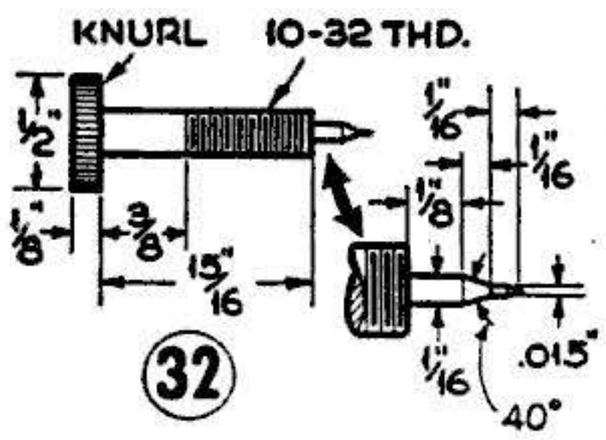
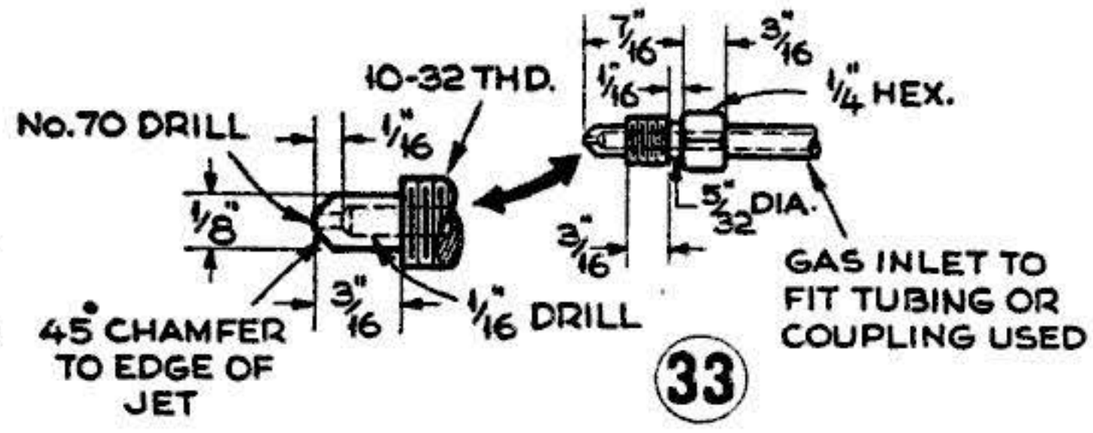
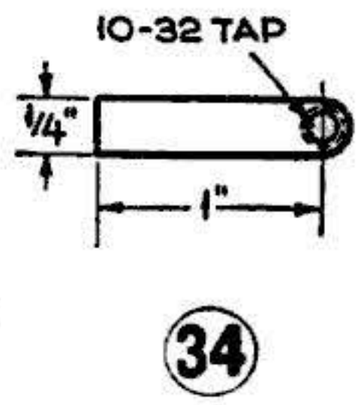
WORKSHEET NUMBER TEN







PART 32, NEEDLE VALVE

1. Turn complete, thread, knurl, and part off.

PART 33, VALVE SEAT

1. Turn complete and thread.

PART 34, LOCKING ARM

1. Lay out, drill, tap, and file to shape.

PART 35, KEY

1. Cut to length and fit to keyways.

.500″ shaft diameters push fits in the ball bearings and do not try to force them on. A .002″ clearance is necessary on the .500″ and .625″ shoulders for the retainers. The .085″ length of the shoulders can vary a few thousandths, but the over-all distance between their outside faces must not exceed .950″. Lay out the rotary-valve hole by the same method followed for the cylinder ports in Part I.

Don't make the 45-deg. chamfers shown at *C* in Worksheet No. 8 until after a trial run. Then, if the engine vibrates badly, the crankshaft can be taken out for filing these chamfers to balance.

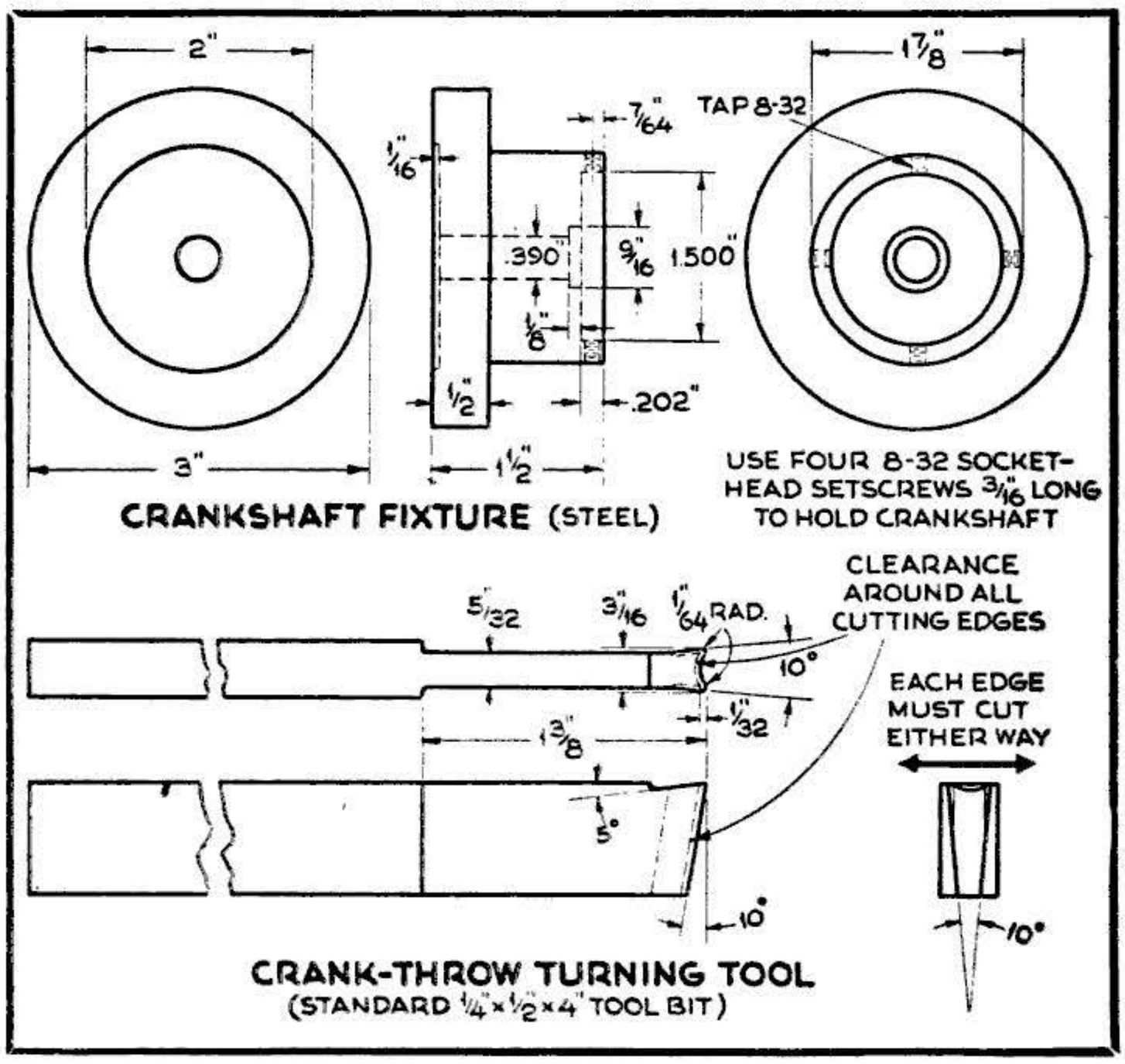
The 1.126″ bore of the timer bracket fits the 1.125″ shoulder on the front of the crankcase. Points can be silver or platinum, if available, or standard auto or telephone-relay points. They need not be more than 1/16″ in diameter.

If the threads for the needle valve and valve seat are cut in the lathe, the parts will be in alignment when assembled. Hold the .015″ diameter as close as possible. The arm, part 34, locks the needle-valve adjustment. Since its travel is restricted to a semicircle, its ⅛″ thickness may require filing to assure locking.

Because of the high compression ratio of the engine, it is advisable to use a VR-1 spark plug. A type V and other types can be used, but the ground electrode will have to be shortened and bent down to within .020″ of the center electrode to decrease over-all height. To make sure the spark plug will not interfere with the piston, cut in the top of the piston a chamfered recess not exceeding ¼″ in diameter or 3/64″ in depth.

The stock and hardware required are available in large cities, but for those who experience difficulty, kits can be supplied. These include hardware and ignition kits, along with the VR-1 spark plug, and also some material such as a duralumin block for the crankcase.

Check each part before assembly, remove burrs and sharp edges, and clean it. Then, as you proceed, remember three points:



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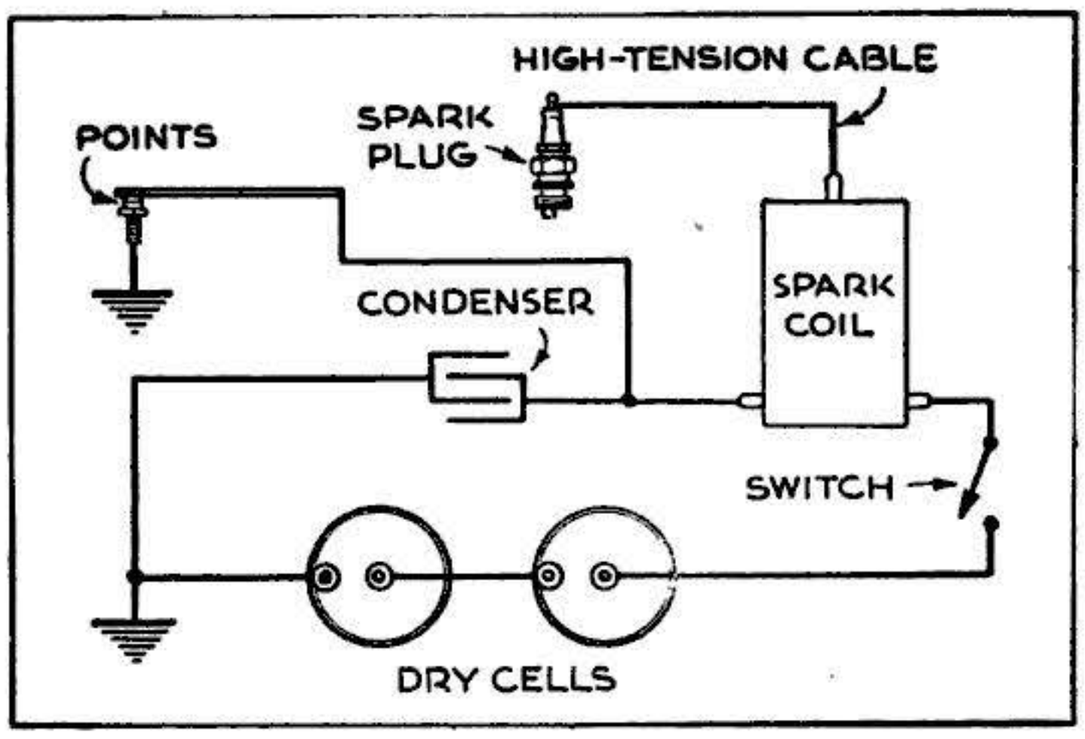

(1) a light film of oil is required on mating surfaces before they are fitted together; (2) screws in dural parts must have a light film of oil on their threads before being put in; (3) all screws must be tight.

Seat the two ball bearings squarely against the inner ends of each of the bearing bores, oiling liberally with high-grade light bearing oil. Lock the retainers in with screws. Assemble the crankshaft in the crankcase bearing, using a .375″ block between flanges and tapping lightly if necessary, and place the crankcase cover on the opposite end, again supporting and tapping for proper seating. Four screws hold the case. Check to see that the crankshaft rotates freely; then screw on the small cover.

Attach the connecting rod to the crankshaft with two cap screws chamfered 45 deg. for clearance in the crankcase. Match the marks on the rod and bearing cap. To be sure the bearing cap is aligned right, use two .005″ shims between the rod and one crankshaft flange during assembly.

Carefully expand the piston ring with the fingers and slide it down over the top of the piston into the groove. Then attach the piston to the connecting rod with the piston pin, which should be a running fit in the rod bearing and a snug fit in the piston. It may be necessary to polish down the center of the pin.

Use a half-and-half mixture of colloidal graphite and SAE No. 30 machine oil to "run in" the engine in the lathe. Apply a few drops around the two connecting-rod bearings and in the oil holes. Hold the piston ring in closed position with the fingers and slide the cylinder down over the piston, seating it on the crankcase, and tighten the four cap screws. The exhaust ports should face you when the rotary valve is on your right.

Apply a few drops of the running-in mixture to the piston through the spark-plug hole, exhaust ports, and rotary-valve intake. Clean the lathe chuck and plate of all chips, and chuck the .375″ shaft extension. Move or swing the engine a few times by hand to make sure all runs free, set the lathe for about 900 r.p.m., grip the fins firmly, and start the lathe. A one-hour running in, broken into 10- or 15-minute periods, is sufficient. Apply the running-in mixture during each pause—never while the engine is running—and touch nothing but the fins. Keep the lathe carriage away. After running in, remove the cylinder and drain the crankcase, apply a few more drops of the mixture, check the connecting-rod screws, and replace the cylinder.

Assemble the timer on the crankcase with the two shoulder screws, part 30. The shoulders are .001″ longer than the thickness of the bracket flange to prevent turning while the motor is running and yet permit adjustment without unscrewing. Attach the timer cam to the flywheel, slide the flywheel against the ball bearing, put in the key, and tighten the setscrew. Remove the contact arm and bend it slightly so about 2-oz. pressure will be needed to pull the points apart. Set the timer cam to hold the points at maximum opening and adjust the contact screw to make the opening .010″. Put in the spark plug and its gasket, checking for piston clearance. The needle valve with its locking arm goes on either side of the boss and the needle-valve seat on the opposite side.

Mount the engine on a steel test block and clamp this block, not the engine, in the vise. Attach the gas tank, and wire as shown in the diagram above. Check for proper spark by laying the spark plug on the cylinder while the flywheel is rotated counterclockwise by hand. Use fresh batteries. Connections must be tight (soldered after final installation). Set the timer so the points break when the piston is at top dead center or a little beyond.

Fill the gas tank with a mixture of 1 part high-grade SAE No. 40 oil and 4 parts white aviation gasoline (90 octane is best), adding a few drops of colloidal graphite. Do not use leaded gas.

Now, open the needle valve two complete turns, wind a starting cord on the flywheel, and choke the engine by holding a finger over the air-intake tube and turning the flywheel two or three times with the cord. Turn on the switch and choke again, this

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time only partially closing the air intake. Remove your finger when the engine fires, advance the spark a bit by moving the timer arm, and slowly close the needle valve until firing is smooth and speed picks up. The engine turns in a counterclockwise direction, viewed from the flywheel end.

An air-cooled engine should be run for only short periods while stationary to avoid overheating, and never at high speed until well broken in. After an hour or two of short runs, apply a few drops of the running-in mixture through the exhaust ports. Run it out of doors, if possible, because of fumes; if not, have the windows open. Don't stand in line with the flywheel. When the engine is mounted in a model boat, car, or plane, be sure the cylinder is exposed to the air stream.

After breaking in, it is safe to rev up on the test block by advancing the spark for short periods. The engine can be run for long periods on the block if a water-cooled cylinder is used. One can be made by turning off all but the two outer fins and brazing to them a 15/16" long and 1⅝" I.D. brass tube having a 1/32" wall. The tube should have an inlet and outlet for siphoning a continuous stream of water.

Keep the engine in good condition and use only a fresh mixture of gas. If it fails to start, check wiring connections, clean the breaker points and check clearance, clean the spark plug and check the gap and spark, and check the batteries. Check also the valve-seat jet opening. If the motor becomes flooded, shut the needle valve and turn the engine a few times to remove excess gas.

Should an accumulation of small errors on the timer make idling or revving up impossible, the timer cam on the flywheel can be moved either way by drilling another 2-56 hole in the flywheel on the same radius.

LIST OF MATERIALS

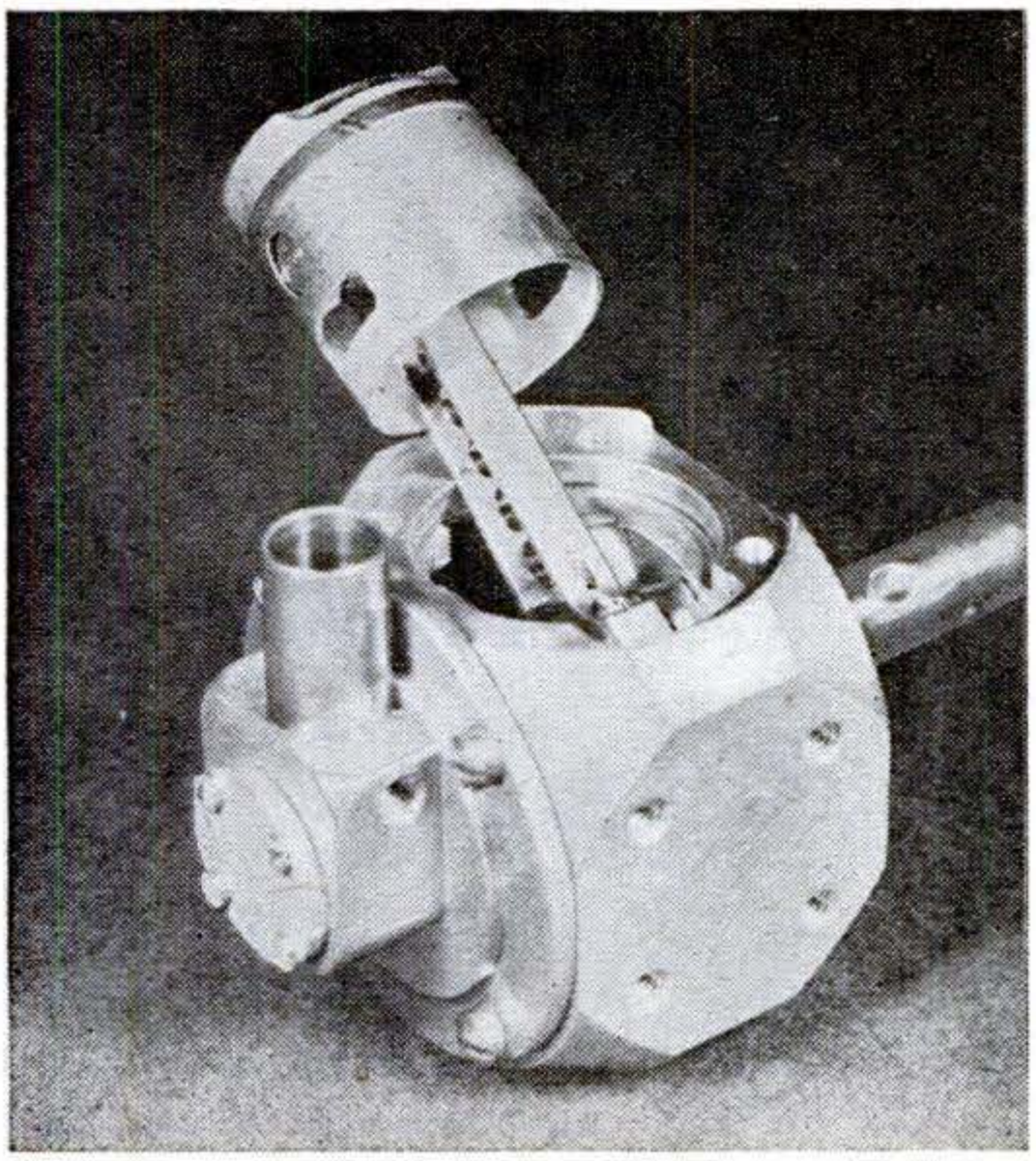
Part No.	*Description*	*Size*
22	Machine steel	1⅝" dia. by 3½"
23	Dural	3/16" by 1¾" by 3½"
24	"	.062" by ¼" by 2⅝"
25	"	3/16" by 3/16" by ⅝"
26	Hard fiber	¼" by 5/16" by ⅝"
27	Phosphor bronze	.020" by 5/16" by 1⅞"
28	Brass	3/16" hex. by 1½"
29	"	Waste from part 28
30	Cold-rolled steel (2 required)	¼" dia. by 2"
31	Rubber-covered stranded copper	6" length
32	Dural	½" dia. by 2"
33	Brass	¼" hex. by 2"
34	Dural	⅛" by ¼" by 1¼"
35	Steel key stock	3/32" by 3/32" by ⅝"
36	Standard spark plug	⅜"-24 thread

LIST OF HARDWARE

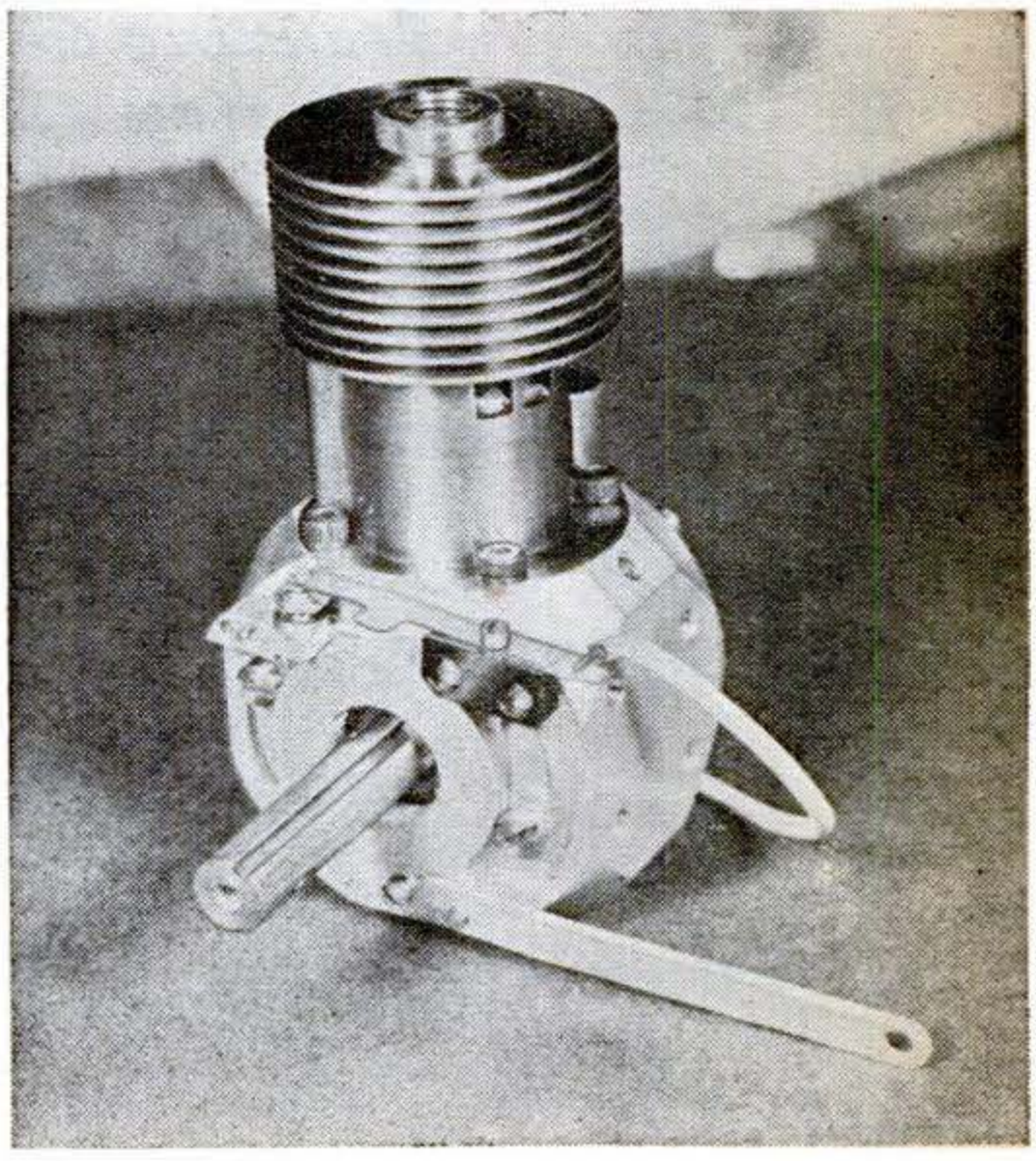
No. Pc.	*Description*	*Size*
1	Socket-head setscrew	6-32 by 3/16"
2	" " cap screw (chamfer)	4-40 by 7/32"
4	Socket-head cap screw	6-32 by 7/32"
4	Fillister-head screw	6-32 by 5/16"
11	" " "	2-56 by 3/16"
1	Flathead screw	2-56 by ¼"
8	" "	2-56 by 3/16"

Note: All screws steel.

Assemble the piston on the connecting rod in this relative position, with the by-pass radius forward when the rotary valve is to the left.



Here the engine is assembled complete except for the flywheel. This view shows how the timer fits on the front of the crankcase.



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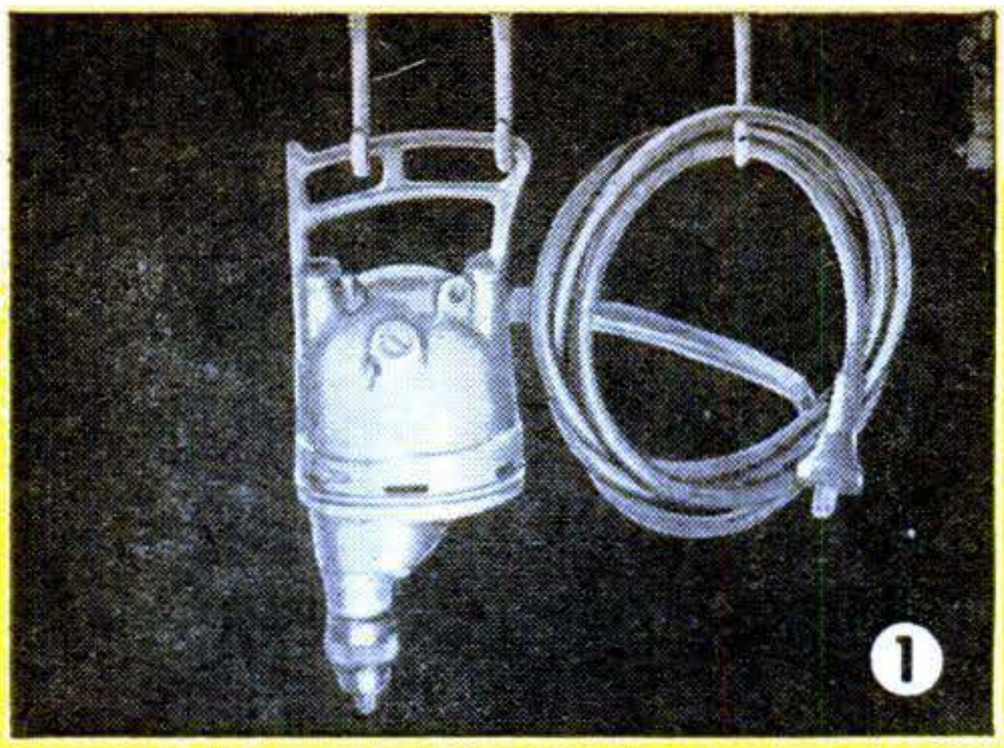
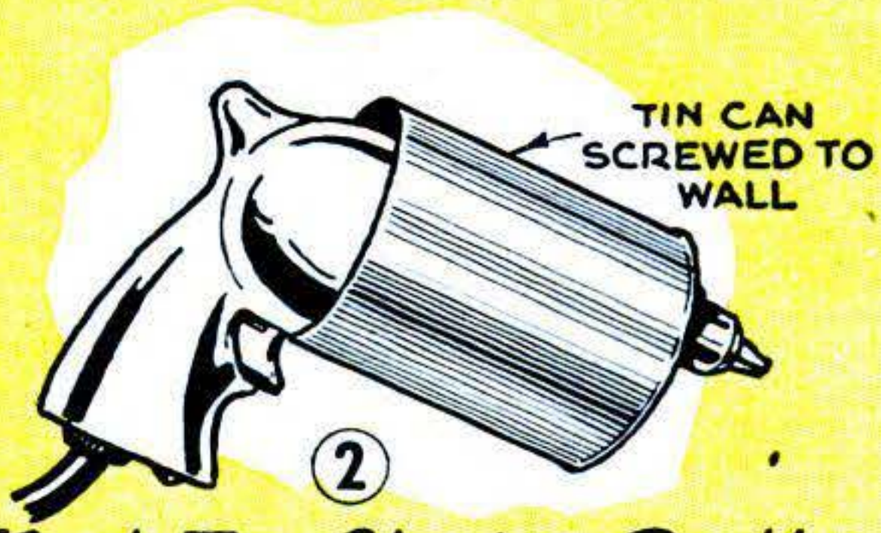
ELECTRIC DRILL HINTS



1



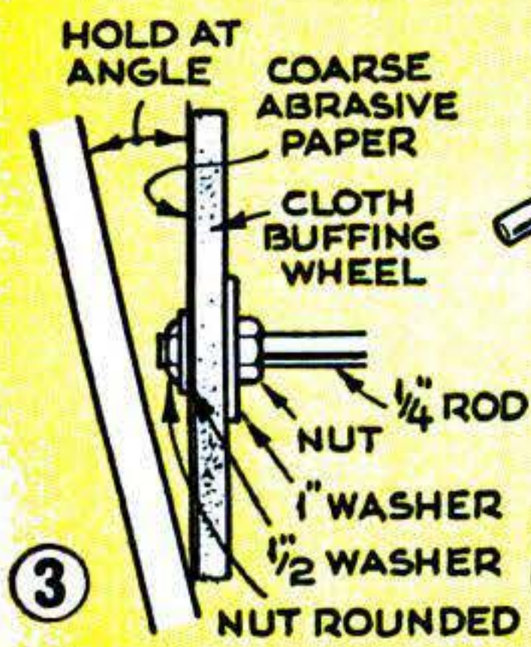
2

Rack For Electric Drill

KEEPING an electric drill conveniently near the bench is no problem if you hang it on two large hooks with the cord coiled on a third, as in Fig. 1. Or a tin can that fits the barrel can be opened at both ends and attached at an angle with two screws, as shown in Fig. 2.

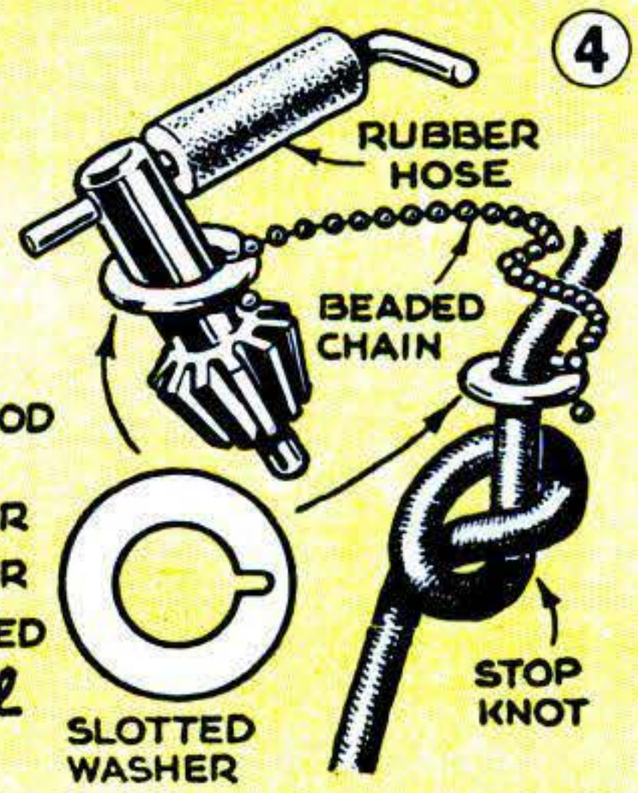
A sandpaper or garnet-paper disk backed by a cloth buffing wheel (Fig. 3) makes a good sander out of the electric drill. Such a flexible disk accommodates itself to curves and even to concave surfaces. Two slotted washers and a beaded chain keep the chuck key handy, as in Fig. 4, which also shows an alteration of the key handle for faster cranking. A knot in the cord near the drill keeps the key from sliding out of reach.

You can make a fast-working butter churn of a covered 1-gal. can and a dasher in the drill chuck (Fig. 5). Bend the dasher to throw the butter downward. Other uses for a drill are winding small springs (Fig. 6), twisting wire (Fig. 7), and turning small wooden parts (Fig. 8).



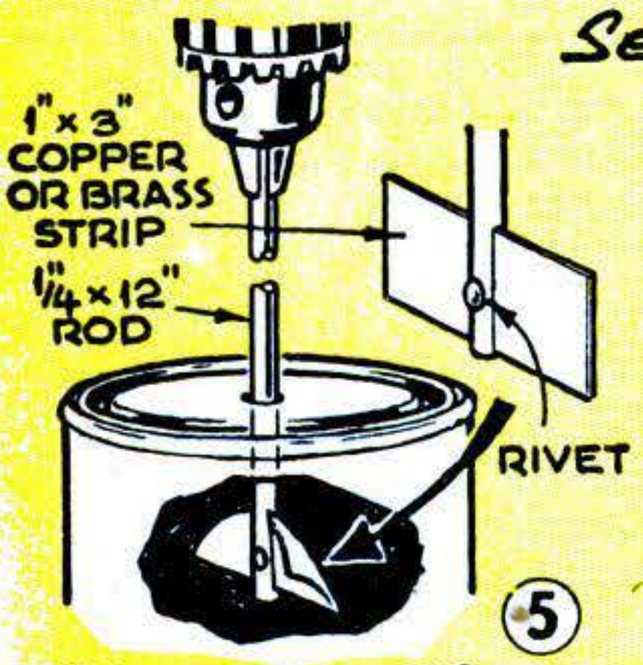
3

Sanding Wood or Metal



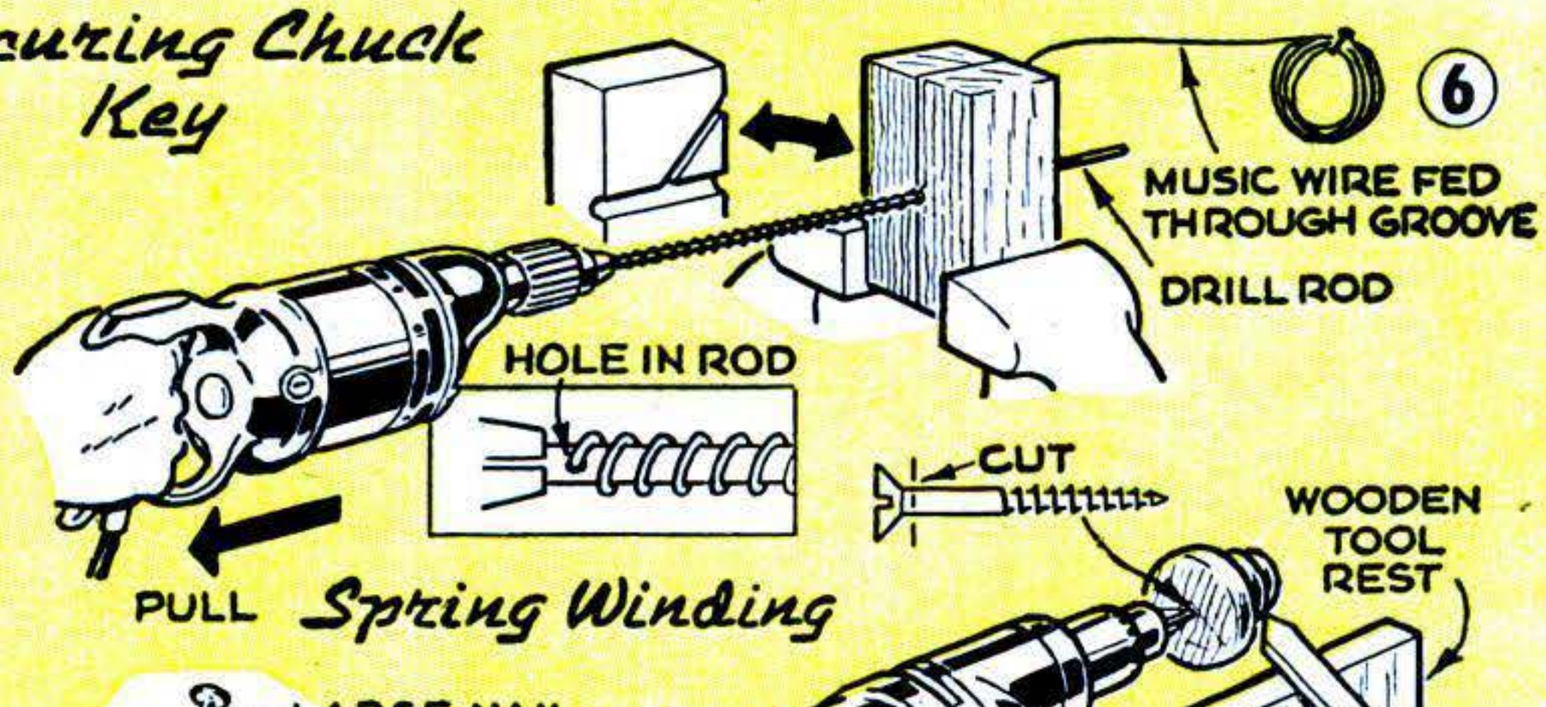
4

Securing Chuck Key



5

Churning Butter

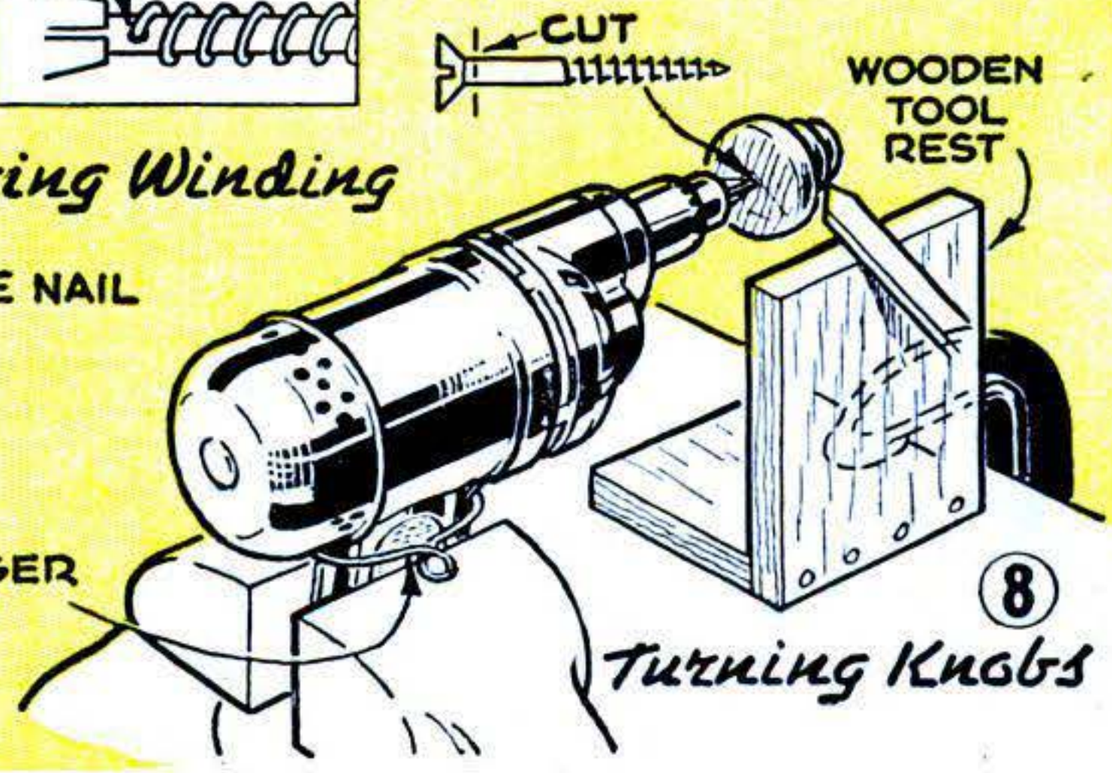


6

Spring Winding

7

Twisting Wire



8

Turning Knobs

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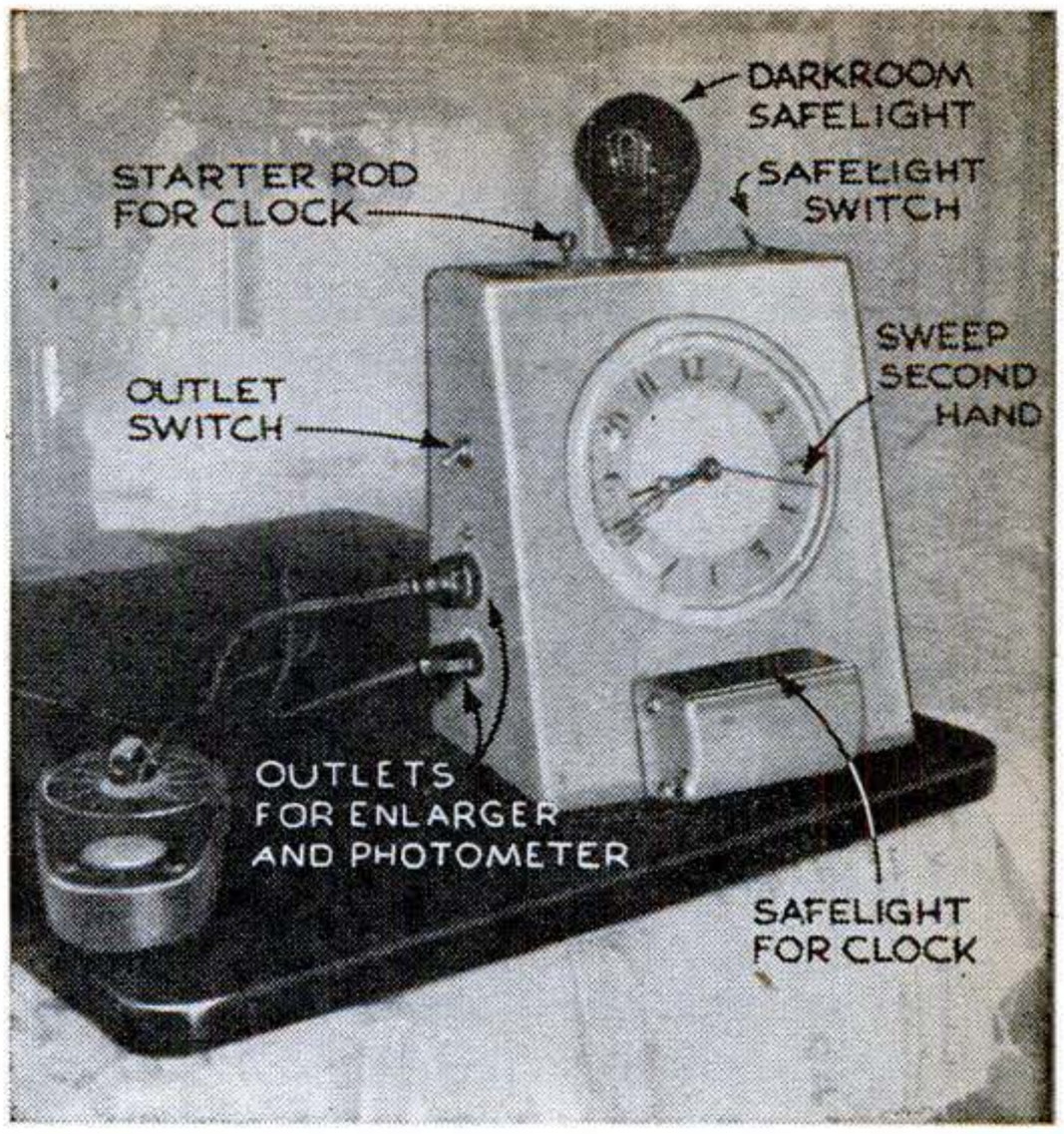
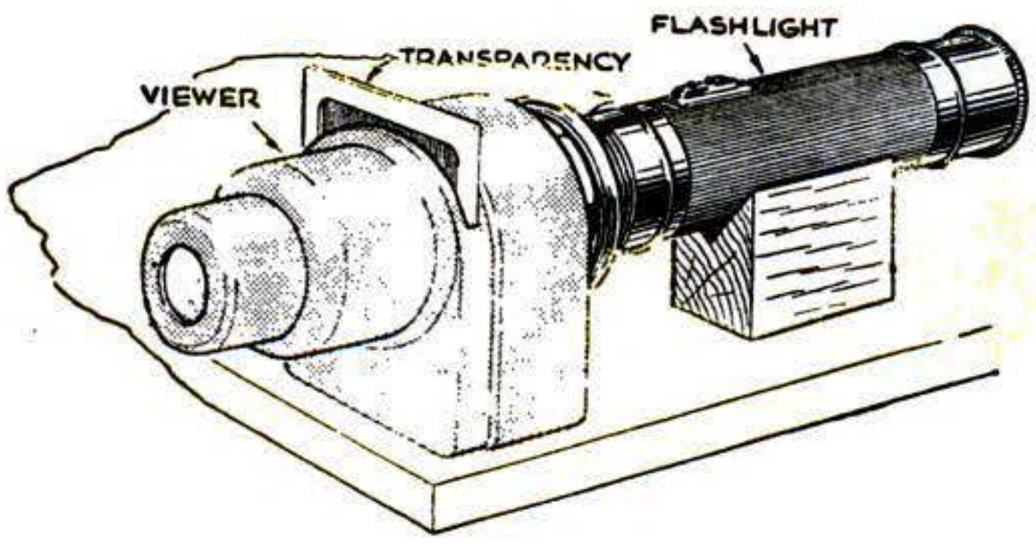
PHOTO IDEAS

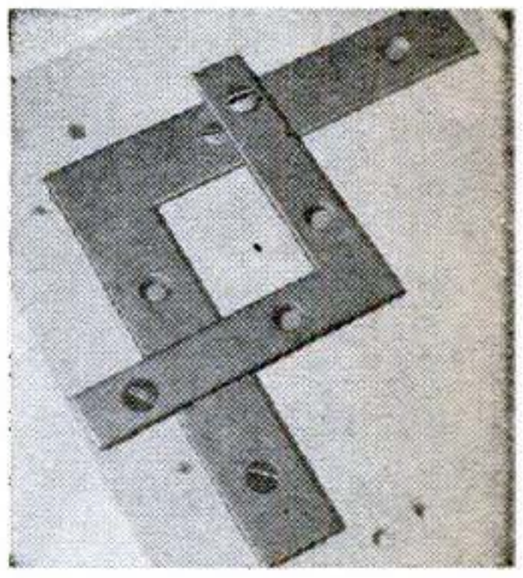
SAFELIGHT AND CLOCK. A compact unit combining safelight, clock, switches, and two outlets was my solution to the problem presented by the single outlet available in the kitchen I use as a darkroom. The size of the unit was determined by the inexpensive electric clock I obtained for the purpose. A miniature-base 115-volt bulb covered by a sheet of red plastic lights the clock face while the orange safelight gives working illumination. The case is plywood with a gray crackle finish.—LLOYD G. BURNETT.

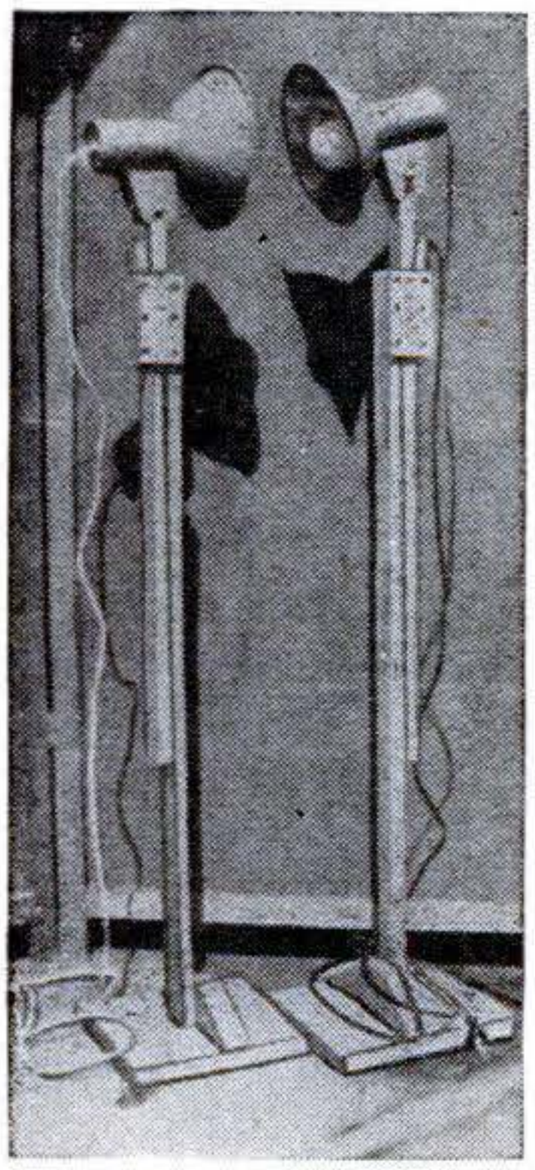


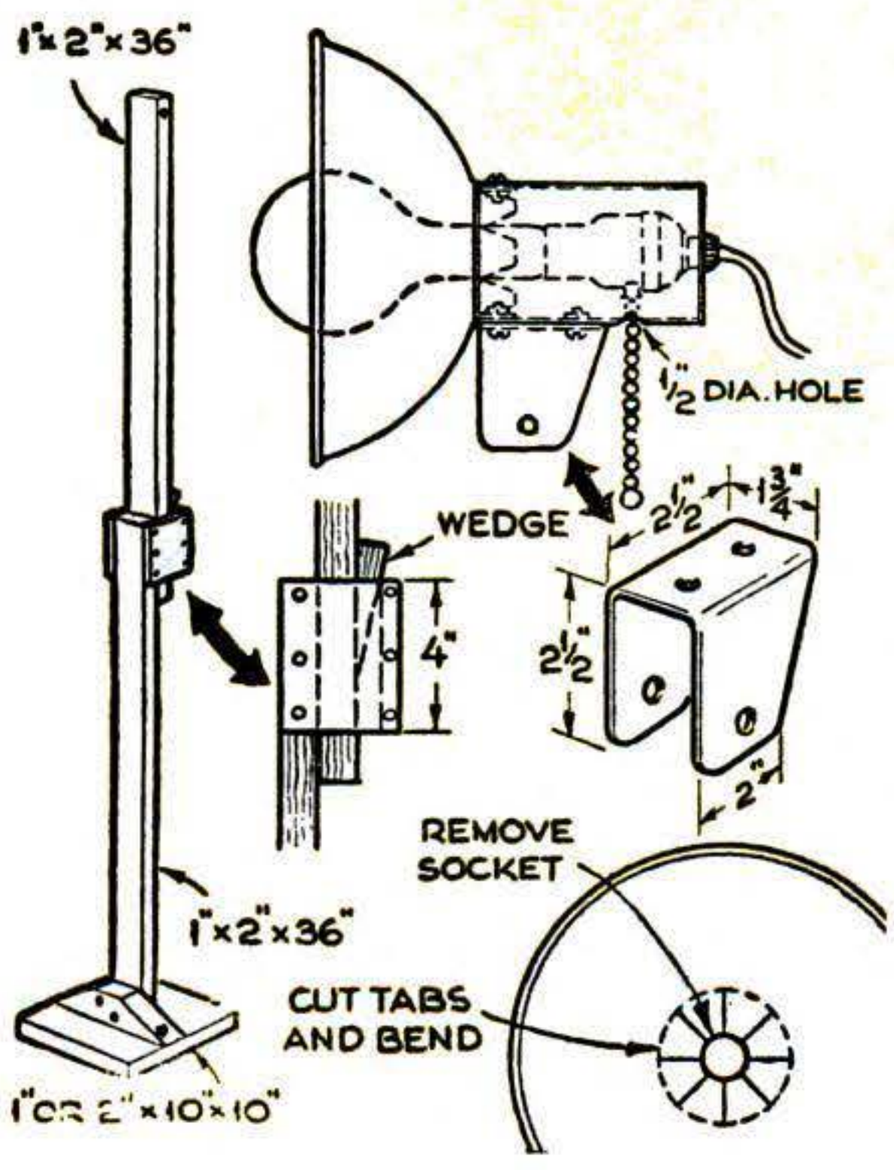


WHILE USING A VIEWER to show friends some color transparencies, it occurred to me that the viewer might be reversed and made to serve as a projector, since it has a focusing lens. The idea worked. A drawing above shows how it was done with nothing more than a flat-lens flashlight against the frosted glass of the viewer. Transparencies are put in the viewer upside down.—J. W. HEATHER.

CUTTING SHEET FILM to a smaller size is easily done with a jig made of two door-brace angles attached to a board with screws as shown. The film is slipped under the top angle and against the inner edges of the lower one. It then is cut by running a razor blade along the outer edge of the upper brace. Paper placed over the opening allows the film to be held firmly.—O. H. M.







REFLECTORS from old auto headlights can be utilized to make handy photographic lamps. After cutting the socket from the reflector with a hacksaw, center a tin can in the bowl, scribe a circle around it, and cut and bend tabs to fit into the can. Form the metal supporting bracket and drill or punch the tabs, can, and bracket for 3/16" stove bolts. Also punch holes in the can for a pull cord and a bushing to support the socket. Pivot the supporting bracket on the adjustable stand with a stove bolt and wing nut.—R. S. W.

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Dream Darkrooms

IDEAL PHOTO WORKSHOPS ARE PLANNED TO CUT DRUDGERY

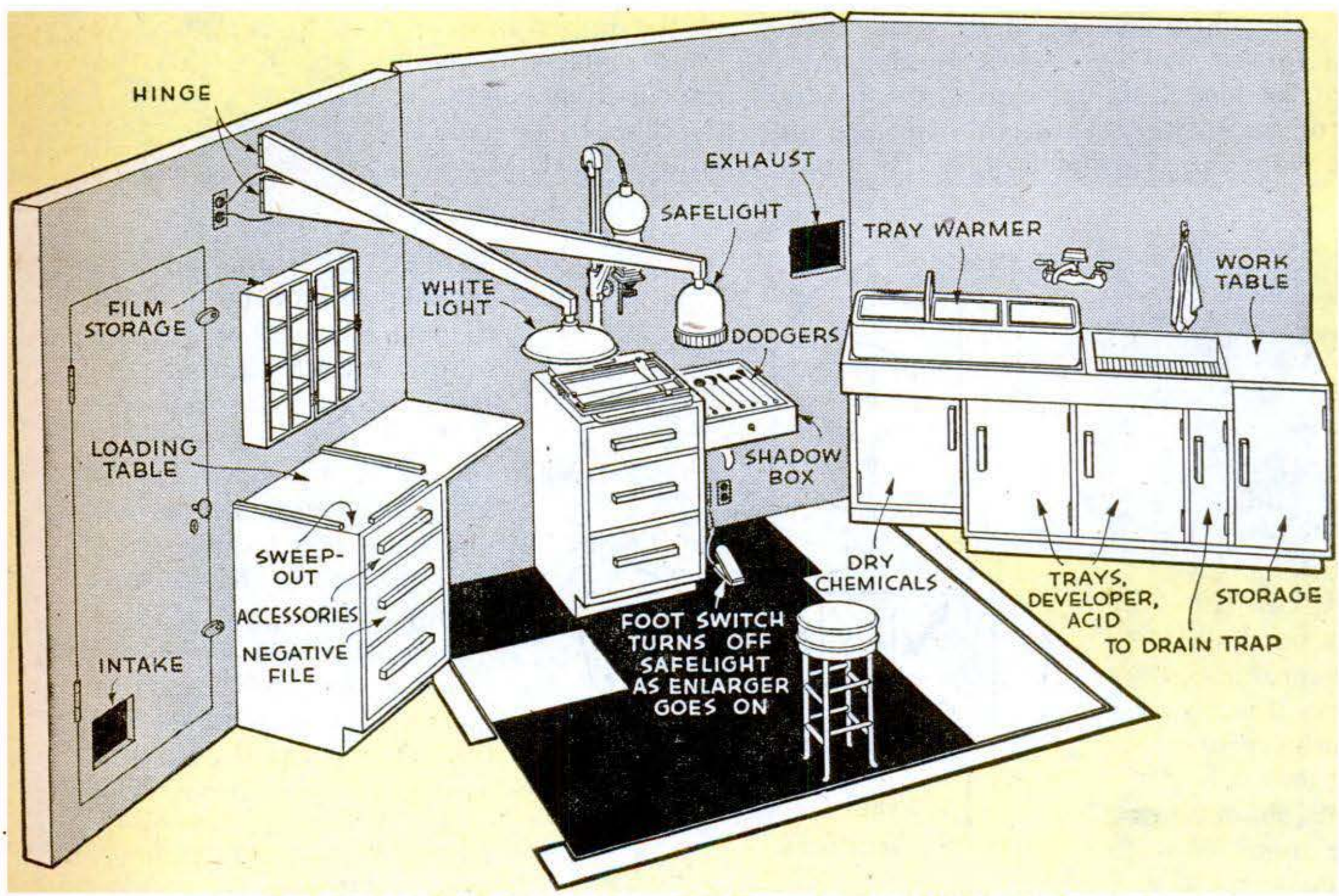
EVEN before graduating from the kitchen table, almost every photographer begins dreaming of the perfect darkroom, where the hypo won't splash into the developer and Aunt Matilda won't come in, with buckets of bright white light, to see how the pictures look. Space and cost considerations may postpone this happy achievement, but they needn't hamper planning.

In order to present a consensus from which you may glean ideas for your own dream darkroom, POPULAR SCIENCE MONTHLY asked a number of writer-photographers to describe the darkroom they now use—or would like to have. Here are their replies.

Edwin M. Love, whose fine workshop photos have illustrated many articles in these pages, writes: "Since I project all my prints, I regard the enlarger as the focal point of my darkroom. My ideal arrangement (see drawing below) would have me seated on a high stool before the enlarger, to my left against an adjacent wall a loading desk on which I can place a box of enlarging paper for use, to the right a rack of dodging gadgets silhouetted on a shadow box, and against the wall to the right a sink and table on which to place an automatic tray warmer that I have designed and built (described on page 187).

"A shallow wall cabinet above the loading desk holds films, placed according to type. In a drawer under the desk are filters and a negative file. The top drawer of the cabinet on which the enlarger stands contains filters for variable-contrast papers, a large reading glass for focusing, a photometer, and viewing filters. Enlarging papers are stored in the second drawer and the dodging set and odds and ends below.

Shown for clarity with the walls swung out, this darkroom features compactness and ample storage space.



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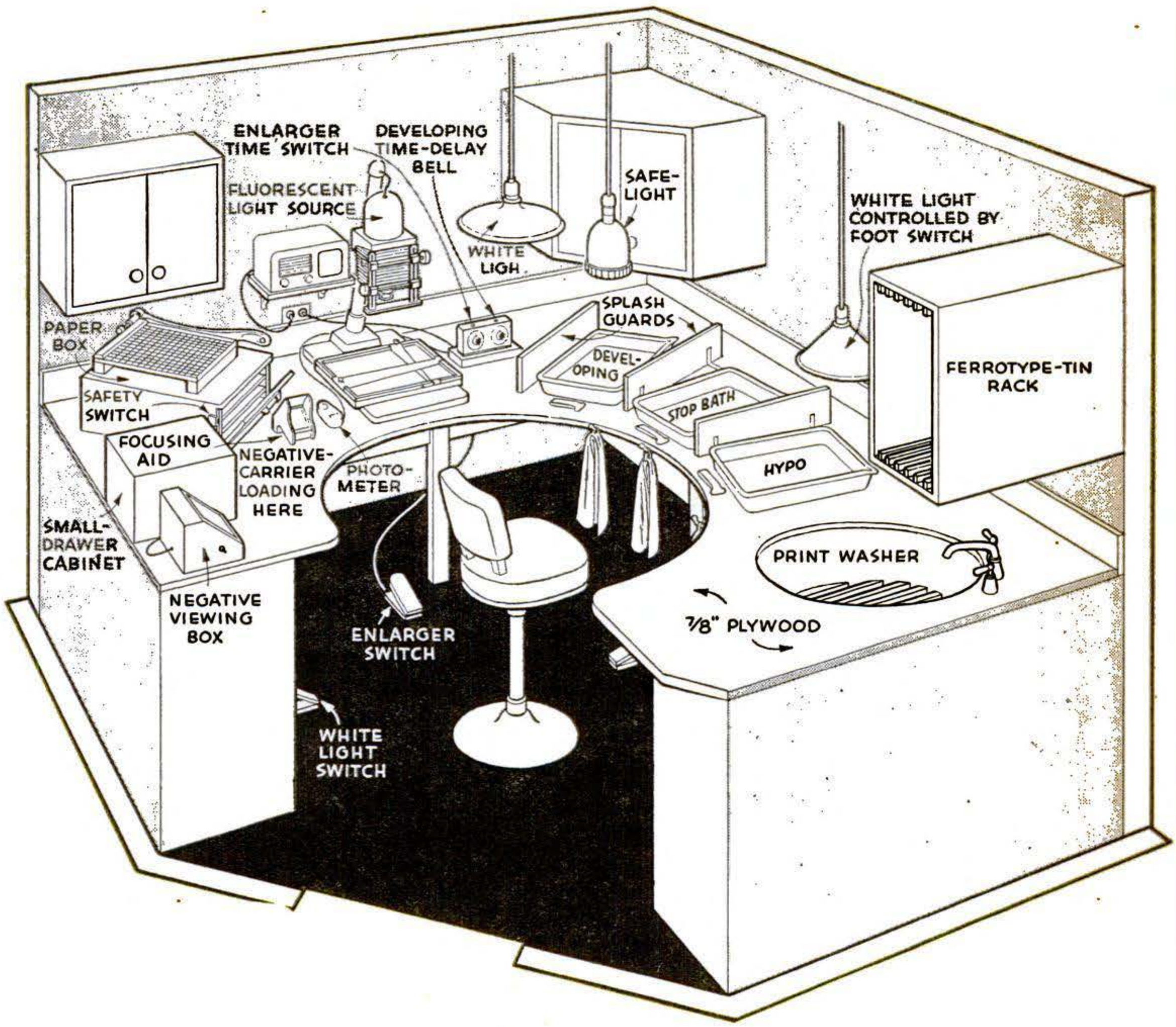

Waste motion is held down in this projection-printing setup. The worker turns in a clockwise direction.

"Above the sink and trays are the safe-light and white light, both mounted on pivoted arms. Under the sink are cabinets for storing dry chemicals, solutions, trays, and other items. At one end of the room are closets for tripods and lighting equipment."

Frank Rowsome, Jr., an associate editor, has no doubts about what he wants in his dream darkroom. He says: "I'd incorporate every facility and arrangement to cut the drudgery to a minimum, especially in printing and enlarging. A motion study of operations in enlarging would suggest, I think, the merit of a production-line setup on a circular pattern, with a swivel stool at the center (see above).

"Describing this setup in terms of a clock face: At 9 to 10 o'clock, a place for studying negatives, loading the negative carrier, and storing negatives, lens tissue, filters, vignetters, and dodgers. At 11 o'clock, a light-tight compartmented box for various sizes and grades of paper, the door of the box equipped with a microswitch to turn off the room light automatically when the box is opened. On top of the box would be a paper cutter.

"At 12, the enlarger. This would have a fluorescent light source (faster and cooler than incandescent lamps), a solenoid-operated shutter, a counterbalanced head, and a footswitch. A photometer and a focusing aid would be placed on or by the easel. At 1 o'clock, two electronic time-delay controls. One calibrated dial would control

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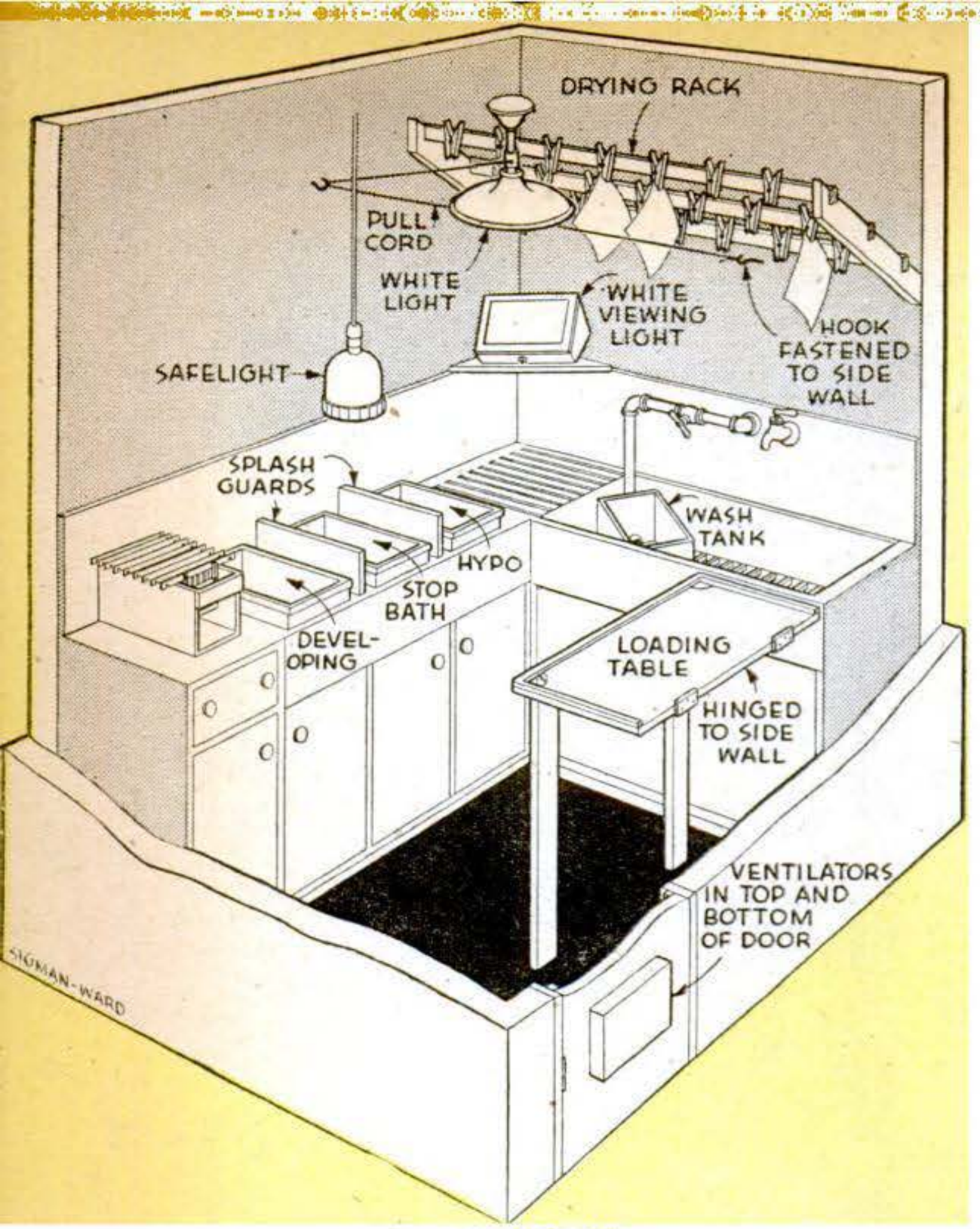


If space is available, a darkroom for film work only has many advantages. In this one, notice the clothespin drying rack over the sink and loading table hinged to the wall.

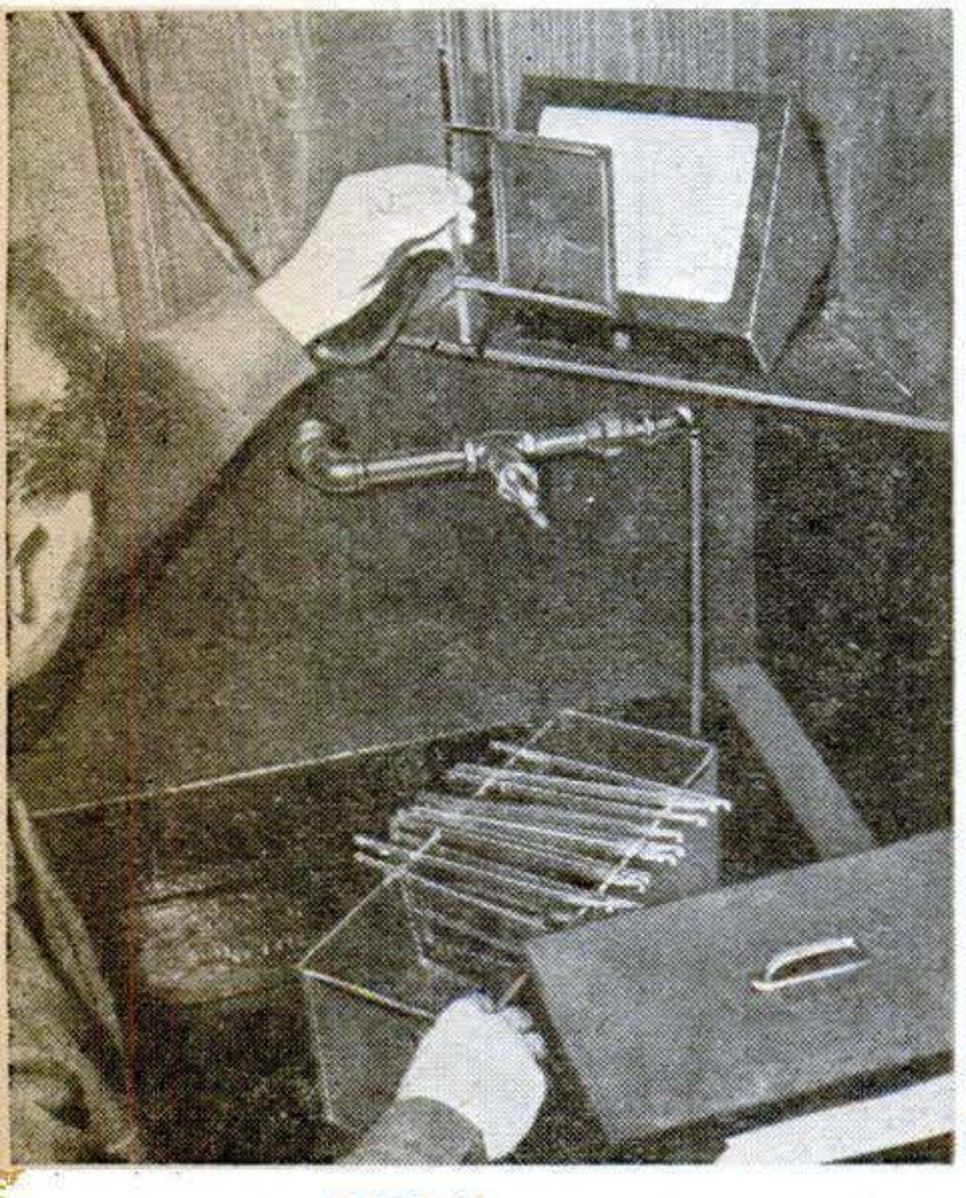
exposure via an exposure-start button. Another would control time-in-developer. After the time-start button is pushed, this gadget would ring a bell or chime when the preset time, say 2 minutes, had elapsed.

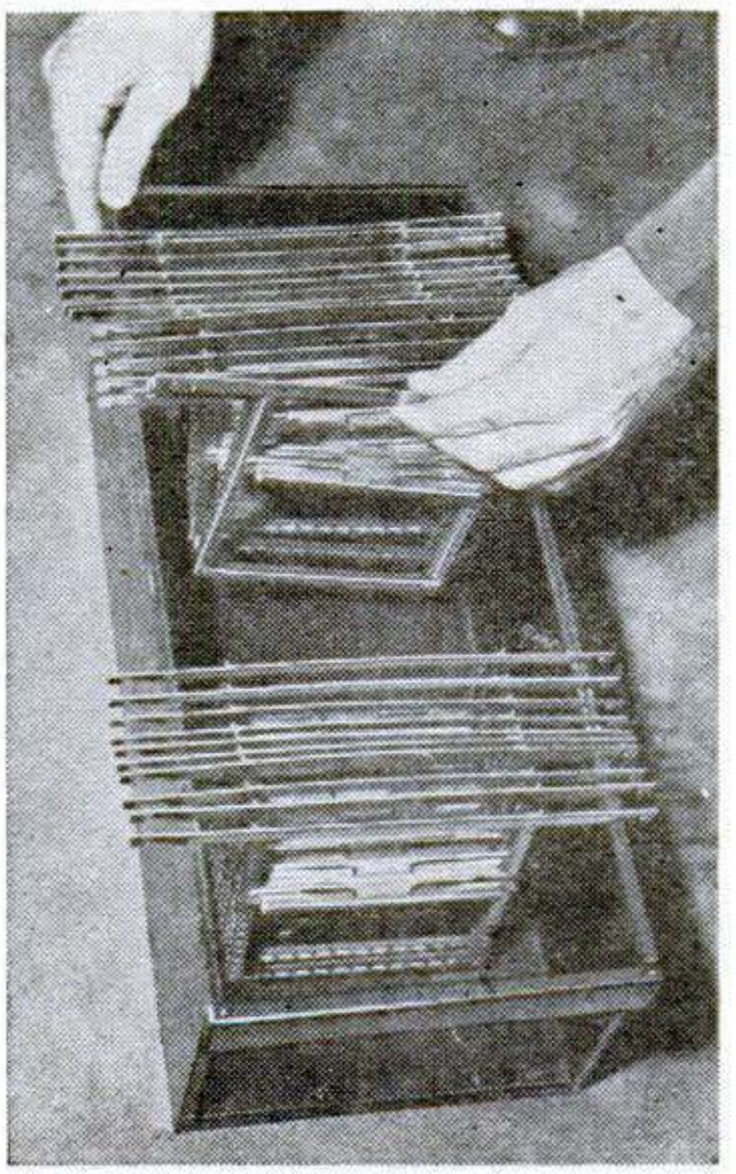
"At 2, 3 and 4 o'clock would be solution trays, with tongs in front and towels on hooks near by. (Ideally, these trays would be set into a jacket through which water could be admitted in temperature-controlling proportions of warm and cold.) Waterproof plywood splash guards would help prevent developer contamination. An orange safelight would be suspended over these trays, rheostat-controlled to give the maximum safe illumination for the paper in use.

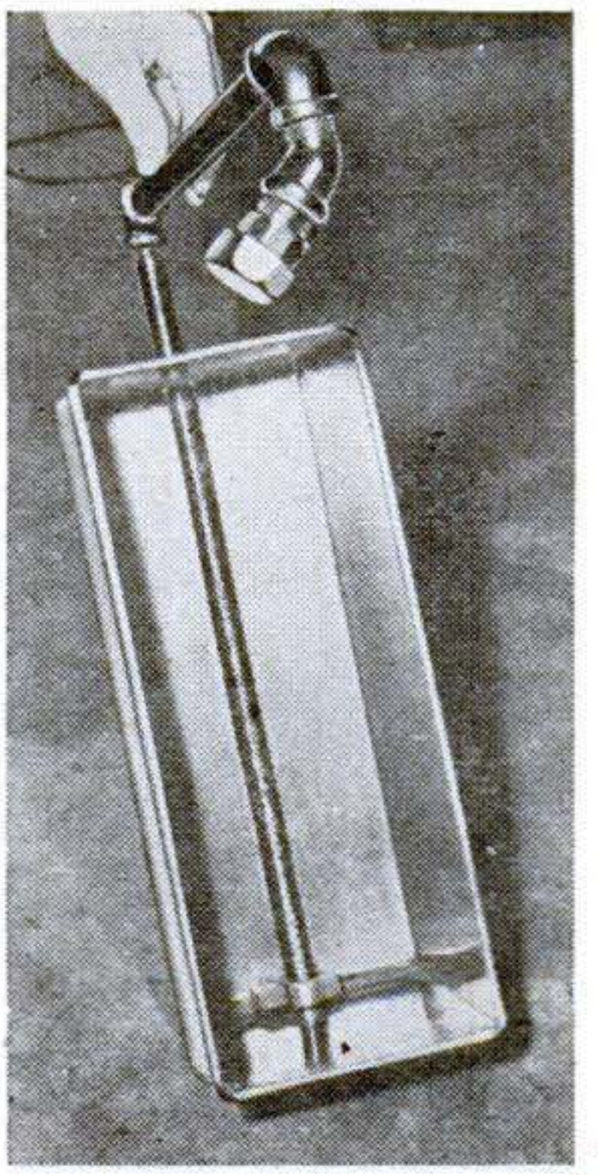
"Beneath the hypo tray would be a footswitch to control the room light; and an identical footswitch at 11, by the paper box, would do the same thing. Both of these switches would be S.P.D.T. ones, wired as in a hallway circuit to permit operation from either spot. Both would be overridden by the paper-box microswitch. At 5 o'clock would be a circulating print washer to avoid the temptation to keep prints in the hypo too long. A small radio is a pleasant companion during long darkroom sessions."

R. W. Emery and Ray Chapin, a writer-photographer team, declare for a separate negative-processing darkroom. "If you are building a new darkroom, consider the pos-

A viewing light, left, placed so wet negatives drip into the sink; a rack for transferring exposed film to developing holders, center; and the cut-film washer, right, as built for use in the film room shown above.







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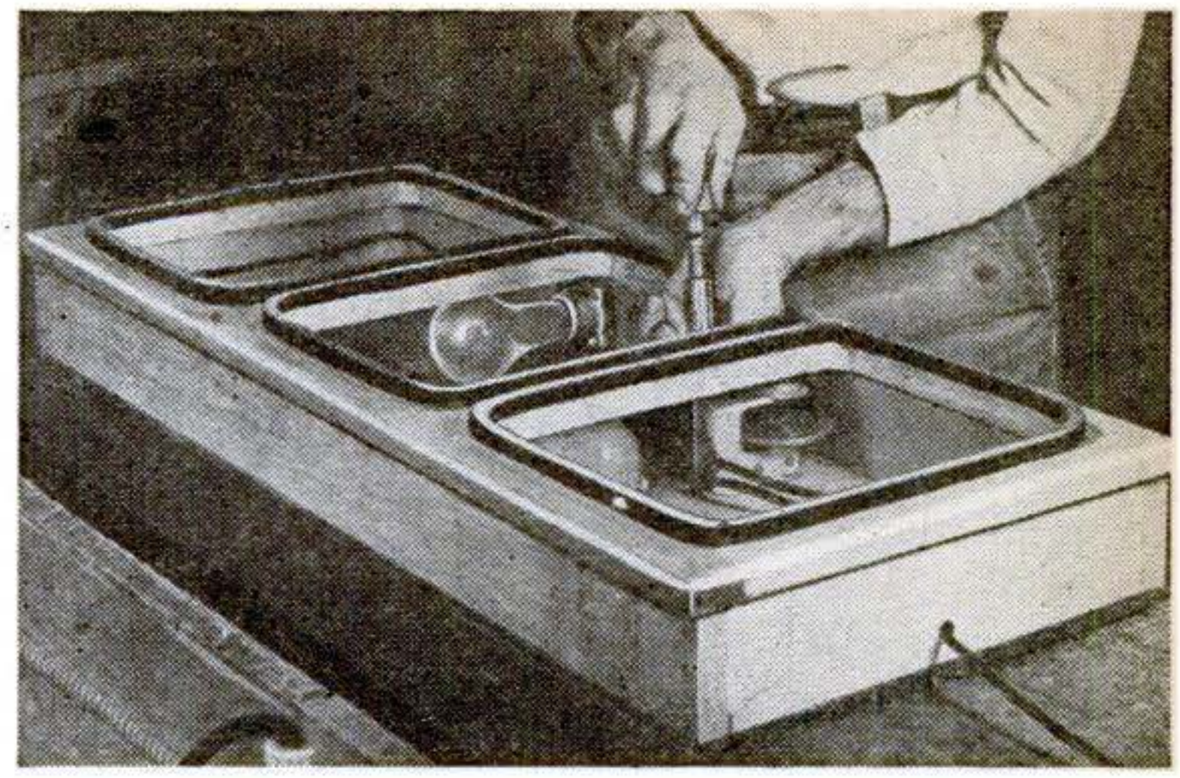
Tray Warmer Maintains Temperature at 68 Deg.

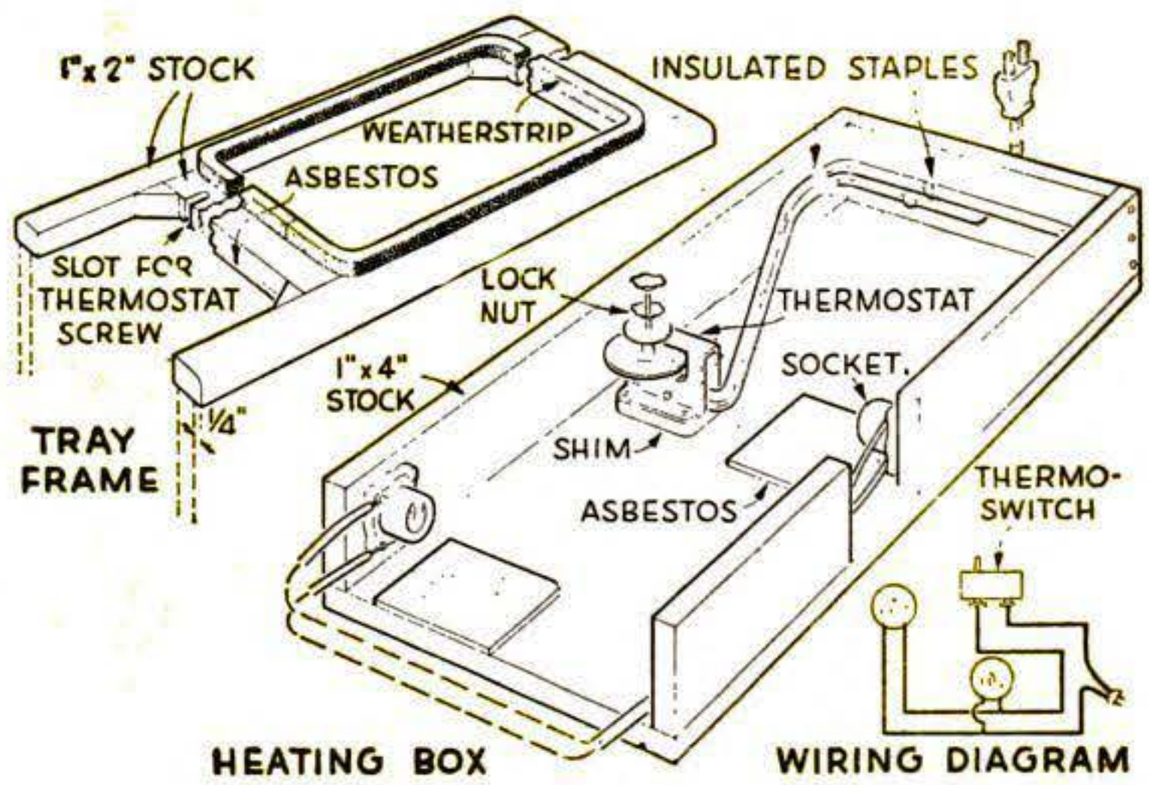
In a cool darkroom this tray warmer will automatically maintain solutions at approximately 68 deg. Two 100-watt bulbs supply the heat and an electric brooder thermostat turns them on and off as required.

Using 1″ by 2″ stock, build a frame with three openings to suit your trays, fastening the butt joints with corrugated nails and bradding small triangular blocks into the corners. Cement and tack sponge-rubber weatherstripping around the tray openings. Then build a box of 1″ by 4″ stock with a fiber-board bottom, dimensioning it so the frame projects ¼″ all around.

Attach sockets as shown, with asbestos-board shields above and below for fire protection. Set the thermostat on a shim to raise the adjustment knob above the frame, locating it below a frame crossbar that has been notched to receive the adjustment screw. Tighten the lock nut enough to require force in turning the knob. After installing the wiring, nail the frame in place and paint the outside of the box with hot paraffin.



Trays rest on ⅜″ by ¾″ sponge-rubber weatherstrip cut lengthwise and cemented around the openings. Weight the trays until the cement has dried.



Set the trays in the openings, fill with water at 68 deg., and put in a thermometer. Then adjust the thermostat until it keeps the temperature at 68 deg.—E.M.L.

sibility of partitioning off a corner as a sanctuary for film work.

"For complete handling and processing of films you will need a loading table, a sink with running water, a place for your tanks, a film drying rack, an overhead white light, a viewing light, and a safelight. Under severe space limitations, you can save room by hinging your loading table to the wall. Nail strips of wood around the edges of this table to keep things from slipping off in the dark, and cut holes in the front corners so dust can be wiped out.

"Rather than grope for a metal switch with wet hands, install an overhead light with a pull switch, and run an overhead cord the length of the room so you can reach it wherever you are. Place your inspection light so wet negatives held before it will drip into the sink.

"If you use cut film, you might make the washing tank and timesaving rack for developing holders shown in the accompanying photos. The tank, made of waterproofed wood or noncorrosive sheet metal, may be equipped with a perforated pipe that enters at one end and extends along the bottom. This allows water to enter at the bottom of the tank, rise past the suspended films, and overflow. Drill the pipe at 1″ intervals.

"The rack is an open wooden box. When you are ready to begin processing a bunch of negatives, place a number of empty developing holders at the far end of the box. As you load each, return it to the near end of the rack. Thus you minimize the chance

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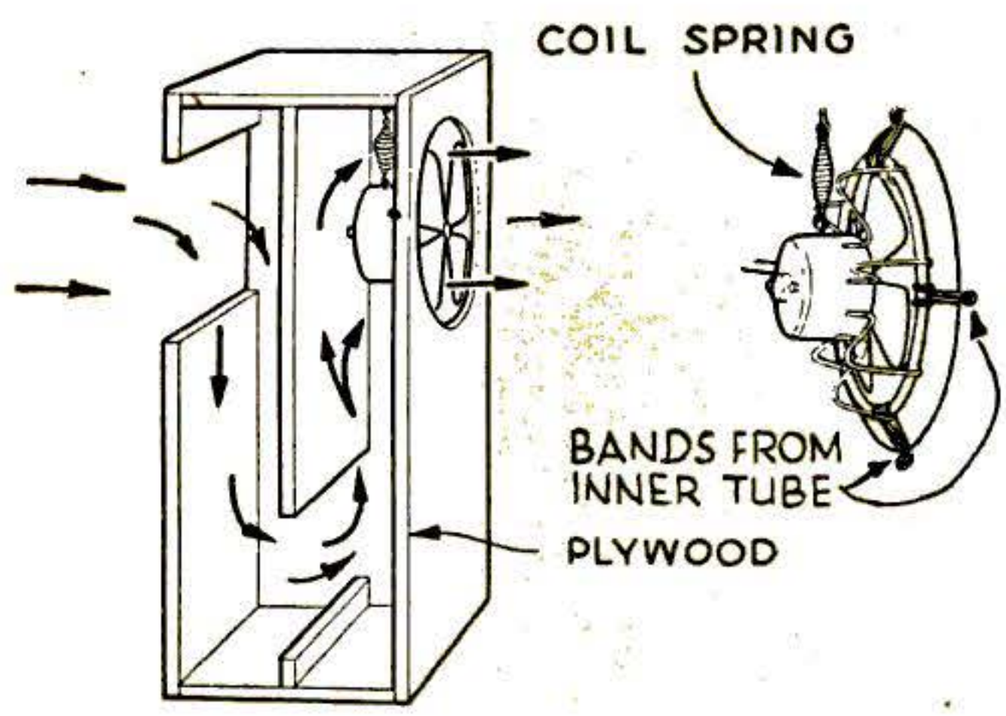
of scratching a film or overlooking a loaded hanger in the dark.

"There are many fancy gadgets for hanging up negatives to dry, but you can make a rack very simply. Cut strips of wood ¾" thick, 1¼" wide, and long enough to extend the length of the sink and drainboard. At intervals, depending on the size of the films, attach spring clothespins, driving screws through the coil spring into the wood. Then mount the strip on two endpieces nailed to opposite walls at a 45-deg. angle with the low end at the back."

C. W. Woodson, whose excellent photos of machining operations are familiar to most workshop fans, says, "I've found that it is better in all respects to have a separate darkroom for developing and loading film. My ideal film room would not be large, but would be well arranged. There would be a sink with hot and cold water, an adjoining drainboard or shelf for my tanks, and on the other side of the sink working space for trays. Against the opposite wall would be a cabinet for film storage, its top at a convenient height for loading film holders.

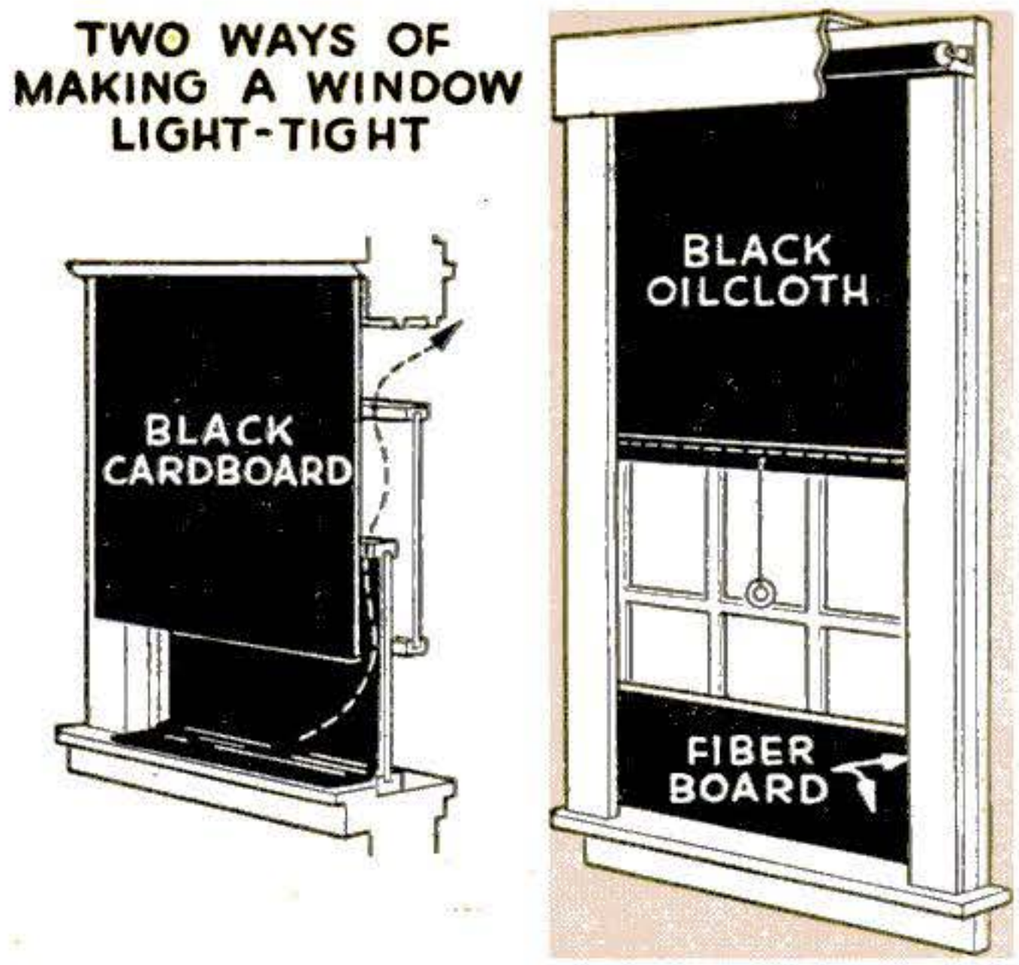
"Printing equipment should be housed in a separate room, large and well ventilated. A wall adjoining another room might be hollow, with a continuous opening at the top on the darkroom side and another at the bottom on the outside to admit air.

"Although the first requisite of both rooms is that they be lightproof, that is no reason they should be dark. If a safelight



Here is one way to ventilate a darkroom. Suspend the fan on strong rubber bands to cut vibration.

is safe close to film, it will be safe also in other parts of the room. For this reason I have painted the walls of my darkroom white and installed a large indirect safelight



Making the windows in a darkroom light-tight is often a problem. This sketch shows how to do it.

on the ceiling. This floods the room with an abundance of light that makes work a pleasure. There are both red and green lights for ordinary and panchromatic film."

Walter E. Burton, who photographs subjects ranging from screw-cutting lathes to women's handbags with equal facility, writes: "Whenever I find that my developer temperature has slipped unnoticed down to 53 deg. or, in summer, crawled to a gelatin-softening 79, I console myself with visions of the darkroom I hope to have.

"In that room I shall have automatic control of solution temperatures. Possibly this will be a water bath, surrounding the trays and tanks, the bath being kept at a happy 65 or 68 deg. by a thermostatically controlled electric immersion heater. Or it might make use of a resistance cable like that employed in hotbeds.

"From the kitchen I shall borrow enough cabinet units, wooden in preference to metal ones, to provide generous storage space below and above work surfaces. The work areas themselves will be covered with resilient rubber or linoleum and will be high enough, say 43", to keep one from getting darkroom bends.

"Luminous paint or sheet material has many potential uses in the darkroom, including luminous areas that will act as safelights, bottle labels, clock markers, and hazard indicators. This material gives off a ghostly glow for hours after being energized by a white-light source, and the color and quantity of radiation can be arranged so it won't fog sensitive materials."

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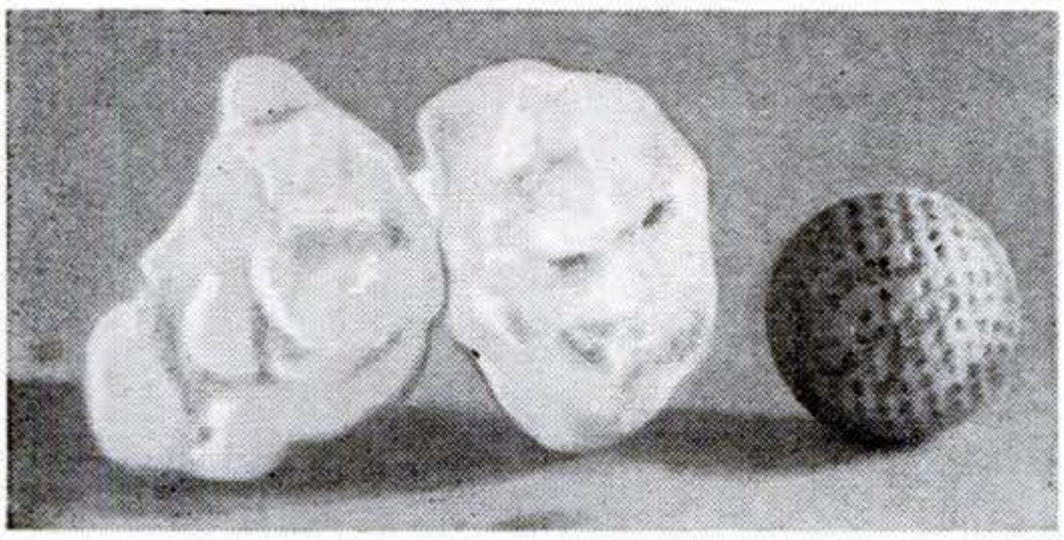
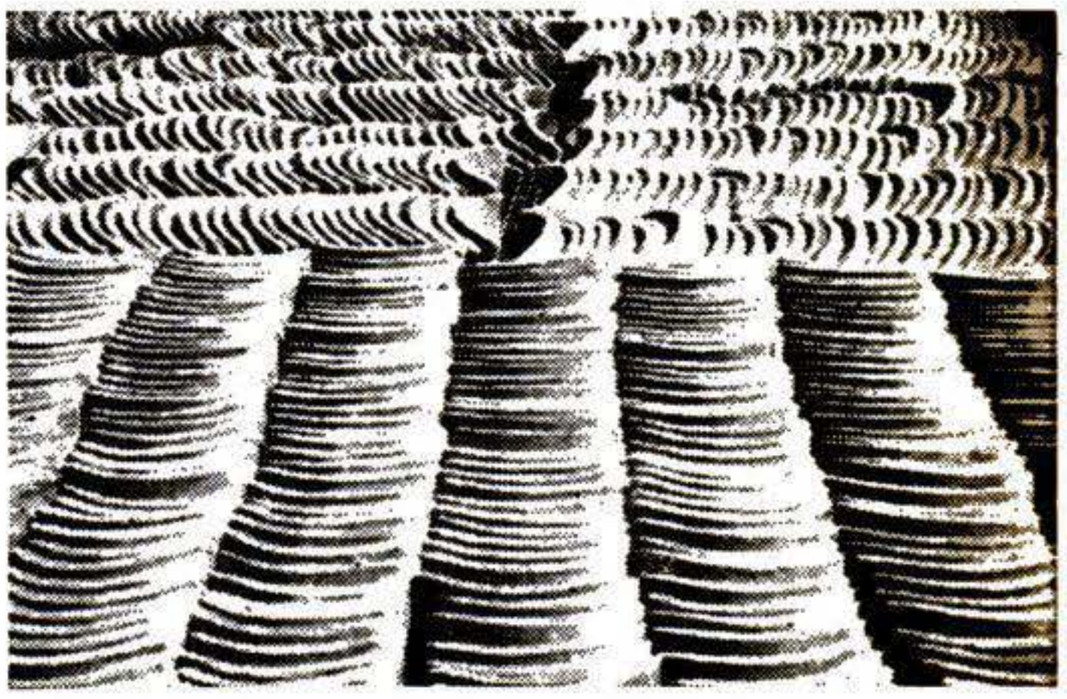
PICTURES with a TWIST

TWO-FACED WOMAN. When Gordon Erickson, of St. Paul, Minn., snapped this picture, he didn't notice that the outline of his subject's hair made a second profile. To make the silhouette he employed the customary method of hanging a sheet over a doorway and placing the light behind it with the subject and camera in front.

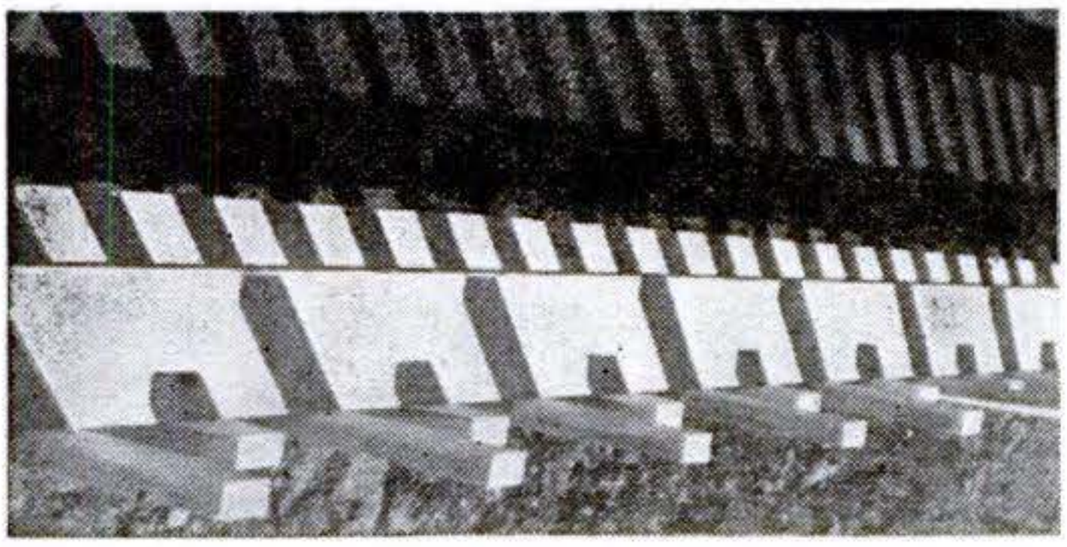


HAILSTONES BIGGER THAN GOLF BALLS. They fell at Summerfield, Ohio, where these two were picked up by Bob Bruce and snapped beside a golf ball for proof. There was quite a bit of damage, he added.



PATTERN FOR BUILDING, not with stacked coins in a bank, but with roofing tiles awaiting transportation. Jerome H. Grossman, stationed with the Air Corps in the Azores, took this picture there and also the one of the top of the fence at left.

PICKETS IN A LINE can be seen if the photo below is turned sideways counterclockwise. Their shadows are on the rails.



COWS ON A ROOF aren't a usual subject even in trick photography, and no tricks were employed on this Montana ranch except to get the cows down again before they could fall. Mrs. Regina Cullen, of Blackfoot, Idaho, took the picture before going for help. The house backs up against the side of a hill, and that's how the cows got up on top. Why they did it is another thing. Mrs. Cullen thinks it was to get a better view of the valley.

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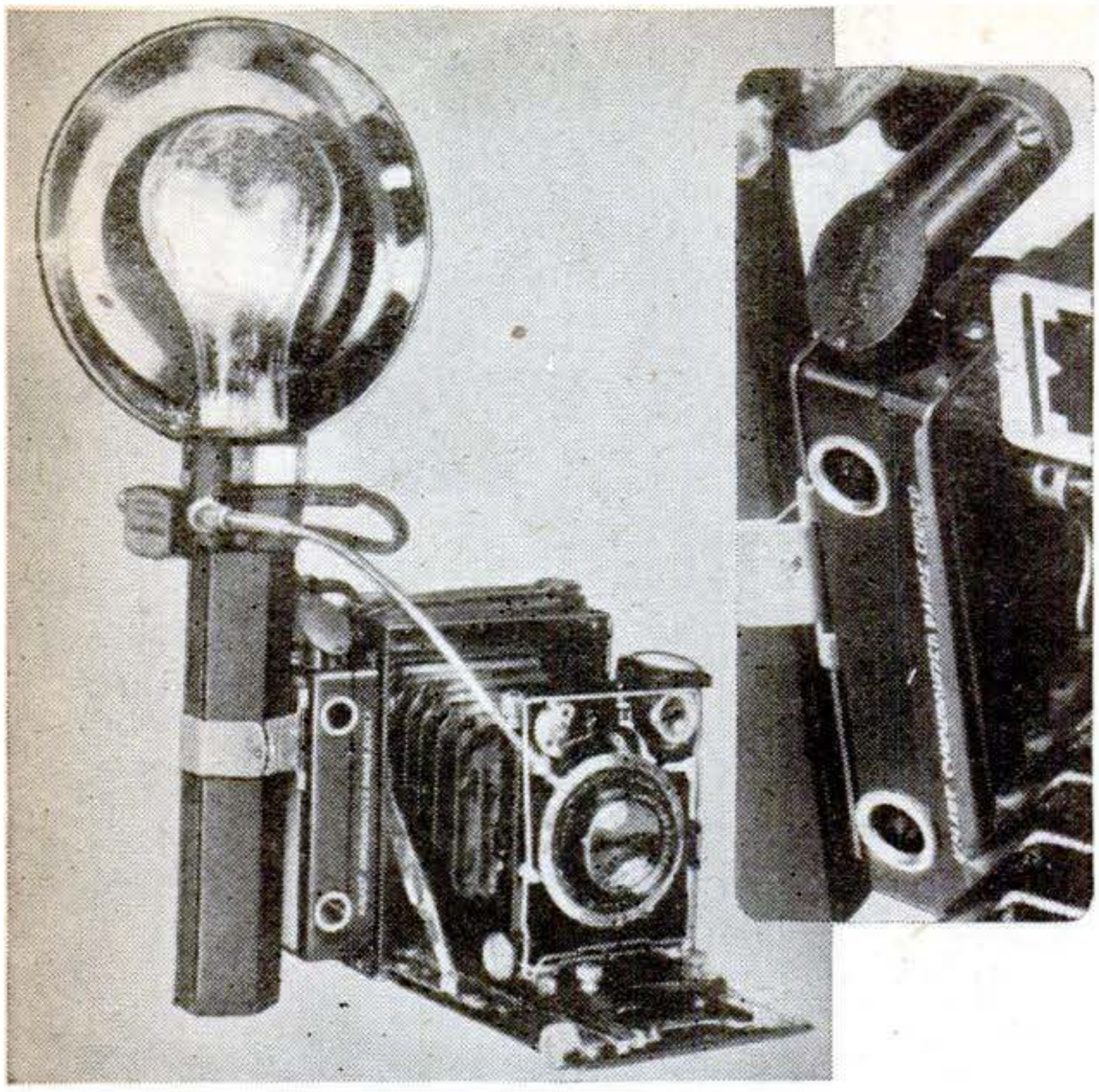
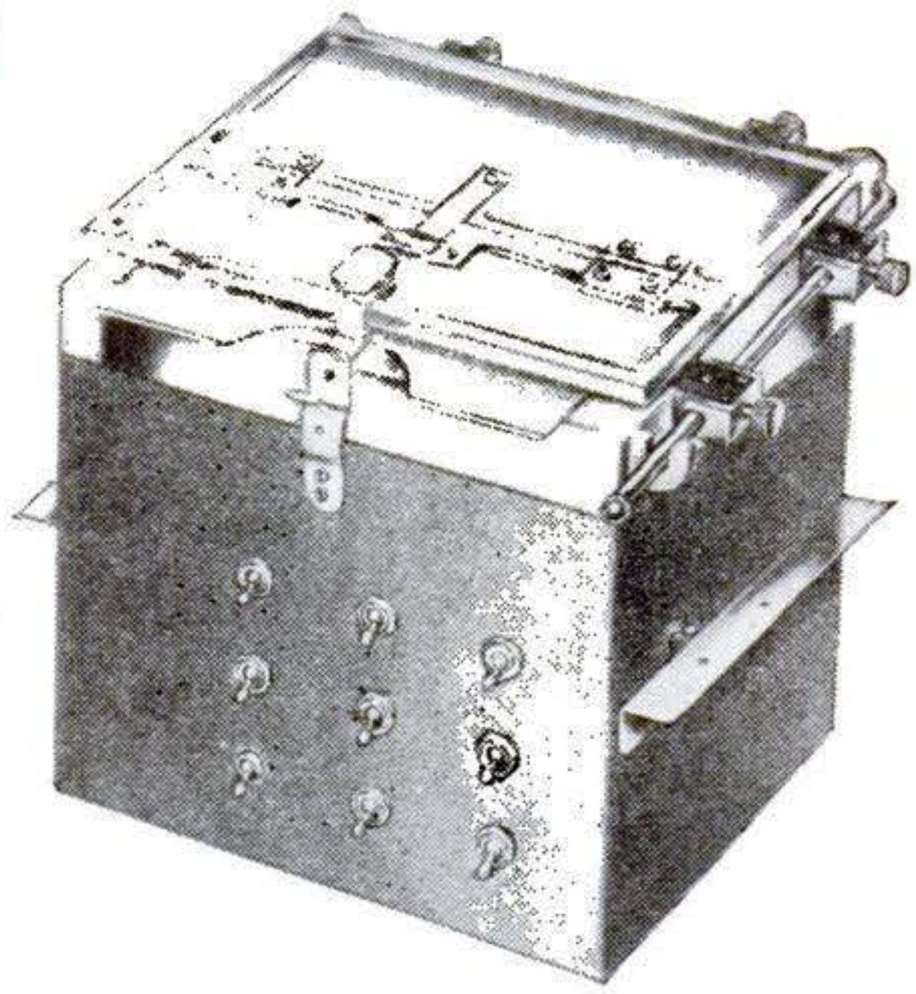
NEW PHOTO EQUIPMENT

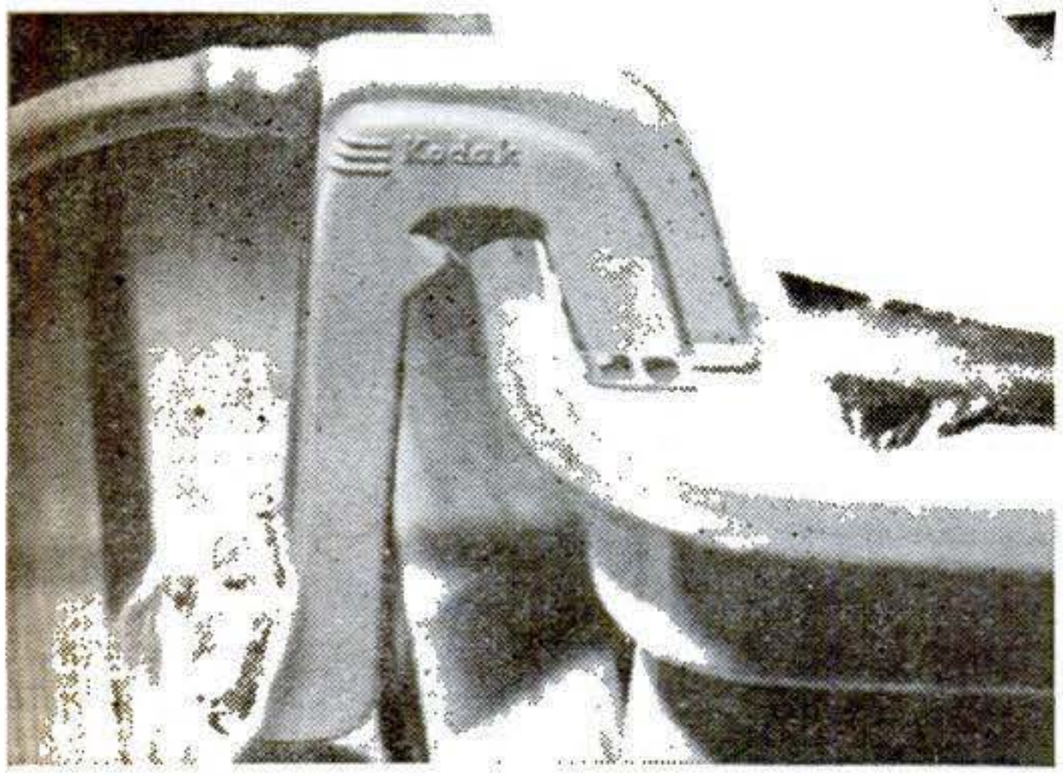


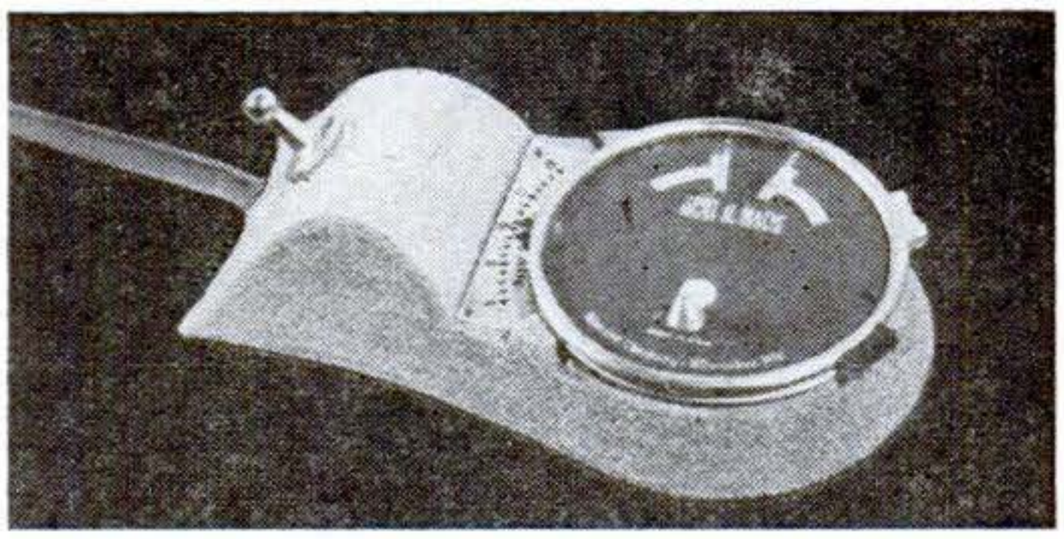
TWIN BEAMS OF LIGHT cast by the Kalart Focuspot make it possible to focus a camera for flash shots in otherwise total darkness. Mounted atop the range finder, the Focuspot makes use, in reverse, of the range-finder optical system. Instead of looking through the range finder and focusing until the two images merge, you throw the light beams, which come from the two lenses of the finder, upon the subject and adjust the focus until the beams are superimposed. For quick-shots, rough framing also can be obtained by centering the light on the subject.

COLD LIGHT is a feature of a contact printer for 5″ by 7″ or smaller negatives produced by the U. S. Photographic Equipment Corporation, Brooklyn, N. Y. Nine 2½-watt argon bulbs supply a monochromatic light to which contact paper is highly sensitive. Exposures, which are controlled by a microswitch on the pressure plate, are said to be shorter than if the same number of incandescent lamps having much higher wattage were used. Each bulb has a switch for dodging.



A PLASTIC TRAY SIPHON is being produced by the Eastman Kodak Company in place of its old hard-rubber model. Equipped with a faucet connection and 36″ of rubber tubing, the siphon clamps to the tray.





EXPOSURE TIME and the required contrast grade of paper are indicated simultaneously by the Spot-O-Matic Enlarging Meter, produced by the Kinnard Company, Milwaukee, Wis. After a negative has been focused, the meter is placed on the easel and the controls adjusted until a spot in the center of a white target balances out. Illuminated figures on the dial then give the information.

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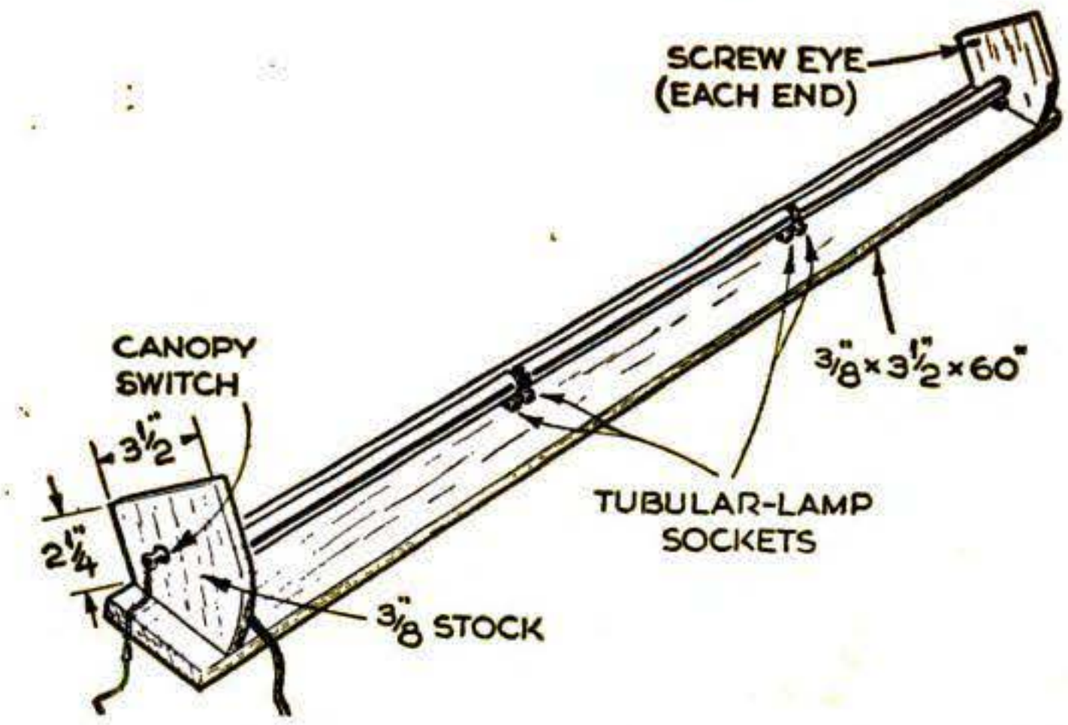
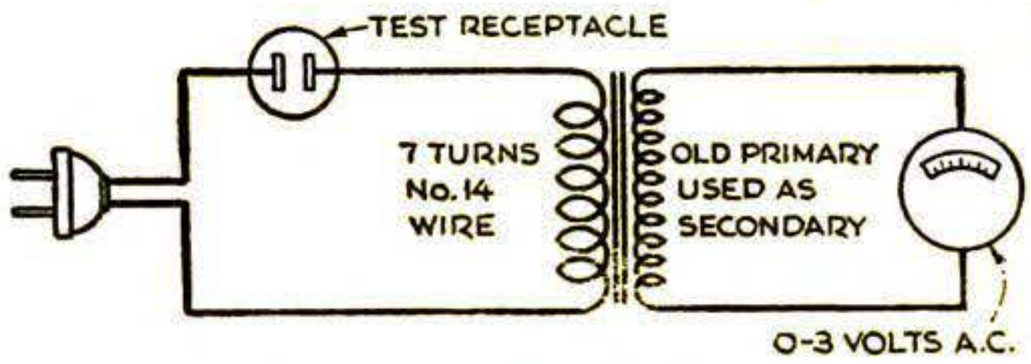


Simple Wall Fixture Puts Soft Light on Bedtime Reading

If you can't fall asleep without skimming through two chapters of a mystery novel, this modern bed lamp will add comfort to your night reading.

Its shade, set at a 45-deg. angle, throws ample light on the pages of a book without causing glare or hot spots, and also provides soft general illumination in the room.

Standard tubular-type incandescent or fluorescent lamps and sockets, a switch, an extension cord, and ⅜" wood stock are the only materials needed. Construction, shown in the drawing, requires merely ordinary woodworking tools. With slight modifications, the lamp can be adapted for use over desks, workbenches, or in any other location where a glareless, broad distribution of light is desirable.—R. B. Lewis.



Wattmeter Checks Current Draw

"Juice-hog" household appliances can be detected quickly with this homemade wattmeter. The only parts needed to make it are an old transformer—a radio power transformer or bell transformer—a 3-volt A. C. voltmeter, and No. 14 rubber-covered wire.

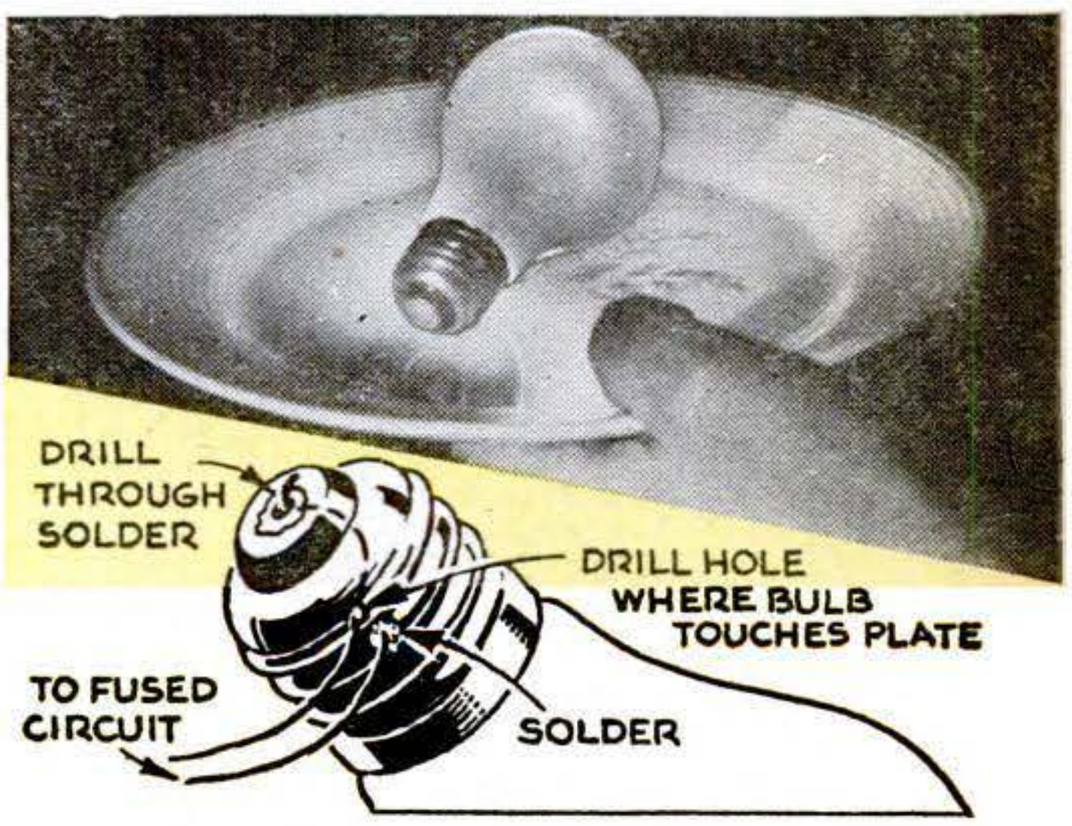
Replace the transformer secondary with seven turns of No. 14 wire, and connect with the new winding as the primary and the old primary as the secondary, in series with the meter. Paste a piece of paper over the meter scale, plug into the test socket a load of five parallel-connected 100-watt bulbs, and mark the needle indication on the paper. By removing one bulb at a time and marking the new needle positions, divide the scale into 100-watt intervals. Closer calibration is obtained with smaller bulbs.

Any appliance within the meter range can then be plugged into the test socket and its power consumption read directly on the meter.—Arthur G. Mac Ginnis.

Trick Bulb Glows Without Wires

An eye-catching illusion, this bulb burns without apparent connection to electricity. Actually, small wires pass through a hole that was drilled in the plate with a small brass tube and valve-grinding compound.

Two tiny holes are drilled in the bulb base—one where the threads touch the plate and one in the solder button. Thread a fine insulated wire through the first hole to the second and solder it in place. The other wire is soldered to the brass thread close to the first hole. For a permanent display, a draped stand hides the supply cord. Connect it in series with a 5-amp. fuse or another bulb.—George Barr.



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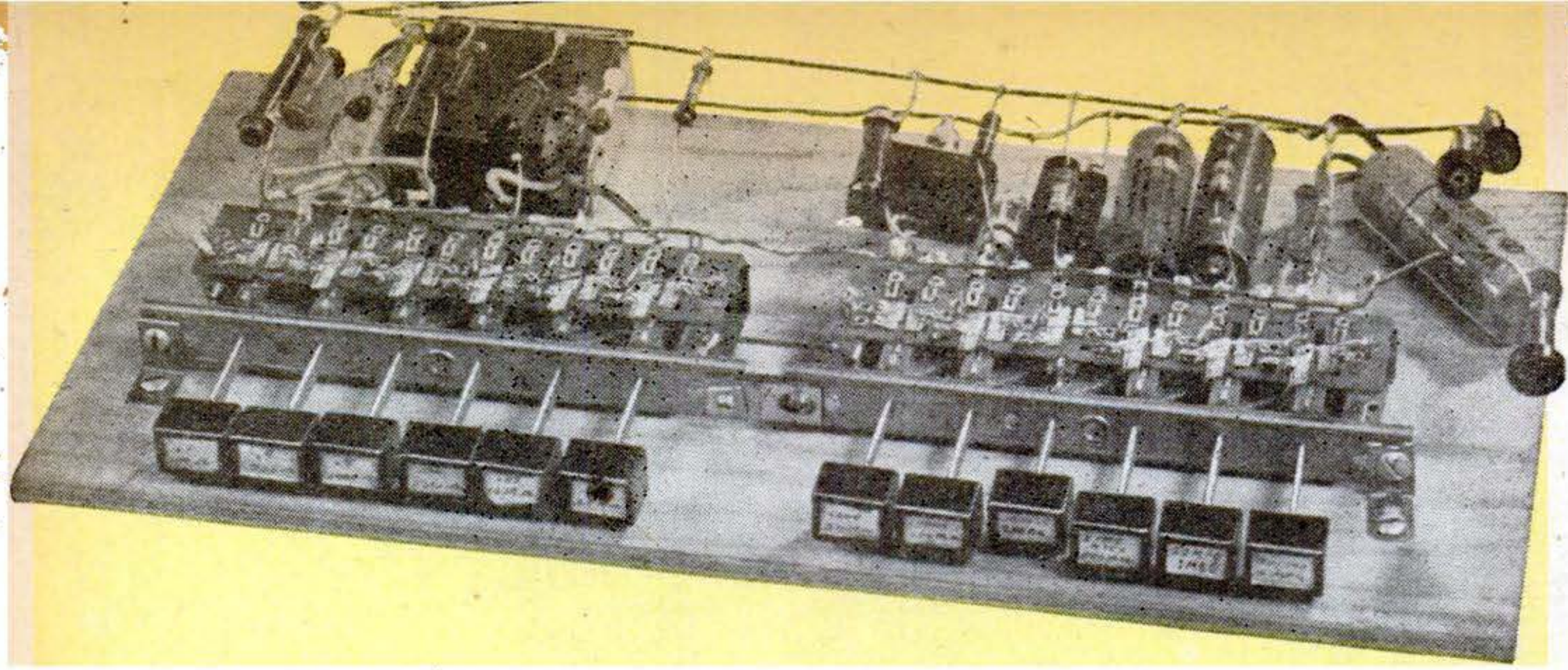
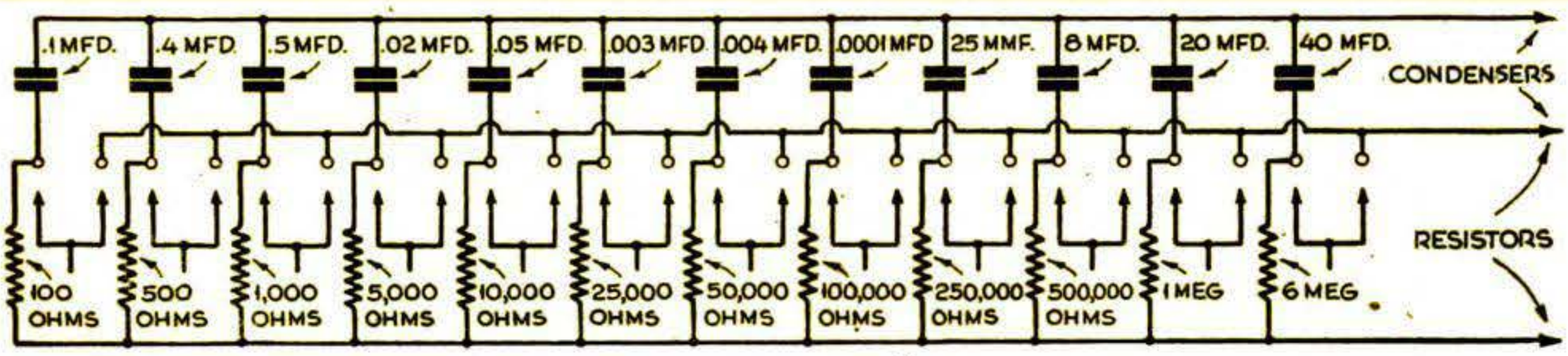


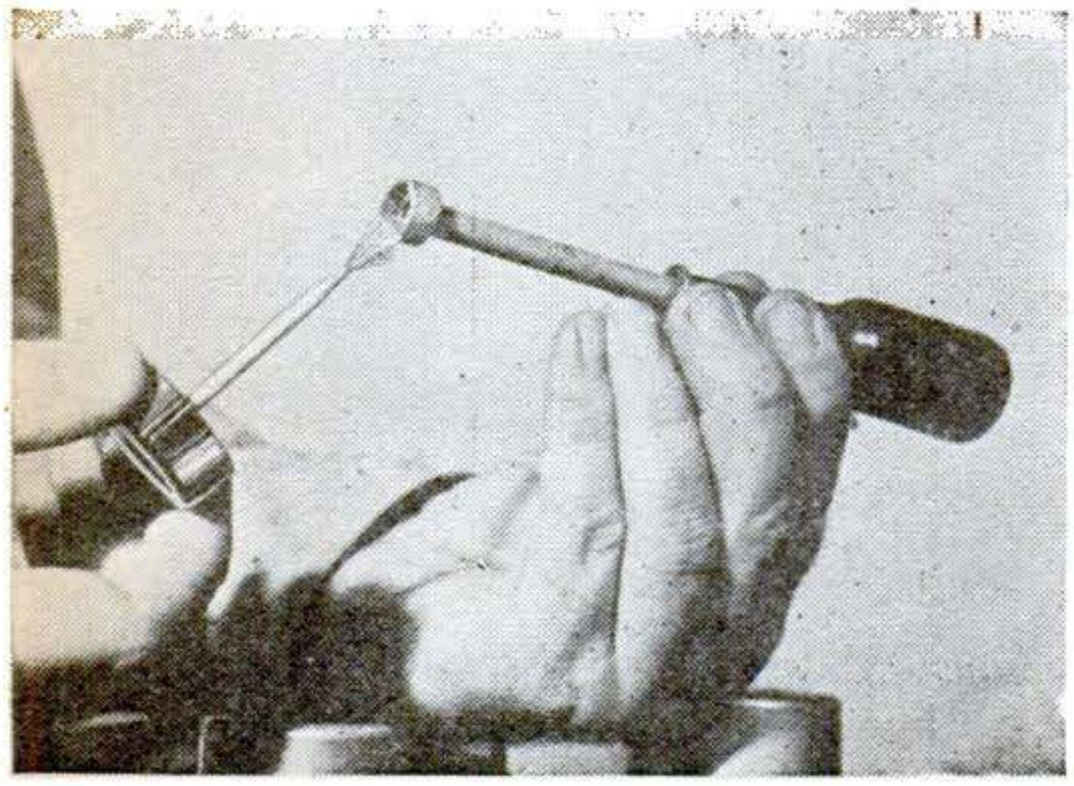


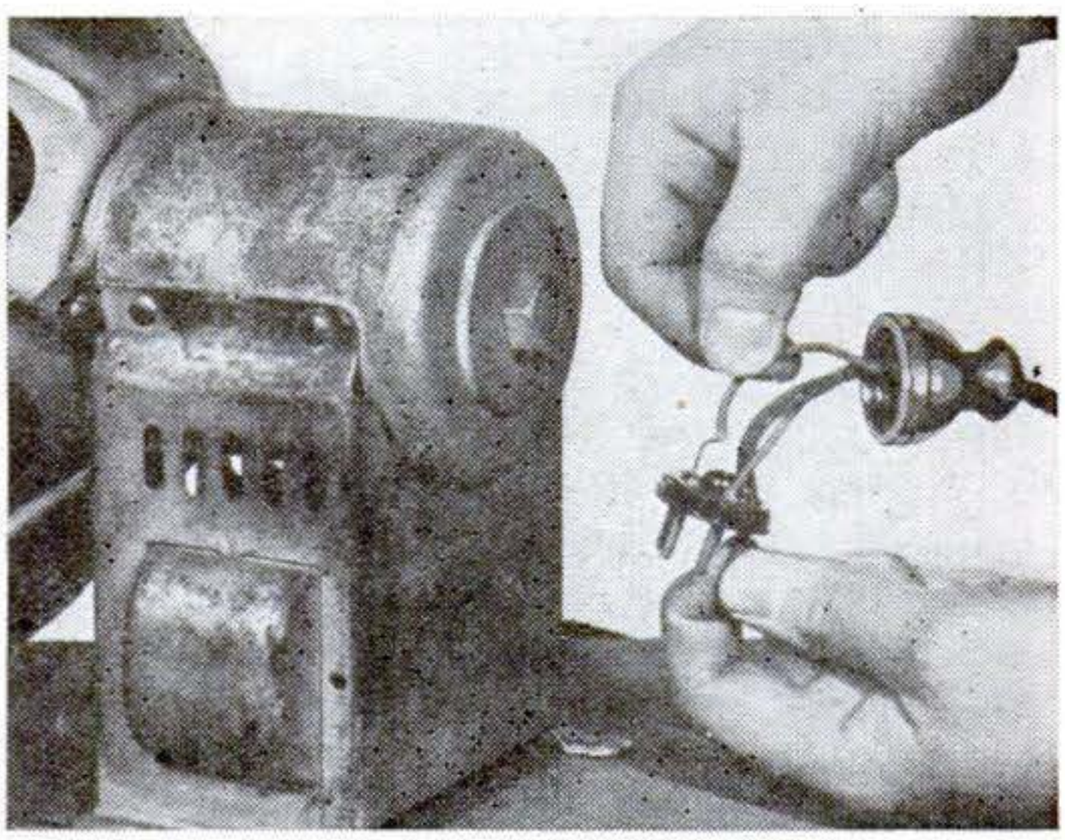
Push-Button Selector Keeps Range of Test Values Handy on Bench

RADIO experimenters who like to try a variety of condensers or resistors in a working circuit before soldering one in will find this bench panel a useful workshop tool. It is built around two discarded push-button selector switches, and employs a group of close-tolerance condensers and resistors. When condensers are used in parallel, their total capacity is equal to the sum of the individual capacities. Adding resistors in parallel gives a total resistance smaller than any of the components; it may be calculated by adding reciprocals. The builder may substitute values in geometrical progression in place of those shown in the diagram.—ANDREW VALENTINO.

Cement in Wrench Holds Nuts

TO REPLACE a nut in some inaccessible part of a radio chassis, put a drop of speaker cement, or other thin, liquid adhesive, in the opening of a socket wrench. Just a slight amount of tackiness is needed to keep the nut in place while you place the wrench over the bolt and engage the first couple of turns.—H. LEEPER.





Check Speaker-Plug Connection

NOISE, hum, or similar trouble in a radio receiver is often due to loose connections at the speaker plug. When checking these wires, turn off the set, remove the plug from the socket, and pull on the individual strands as shown above. Resolder loose wires to the plug prongs.—H. L.

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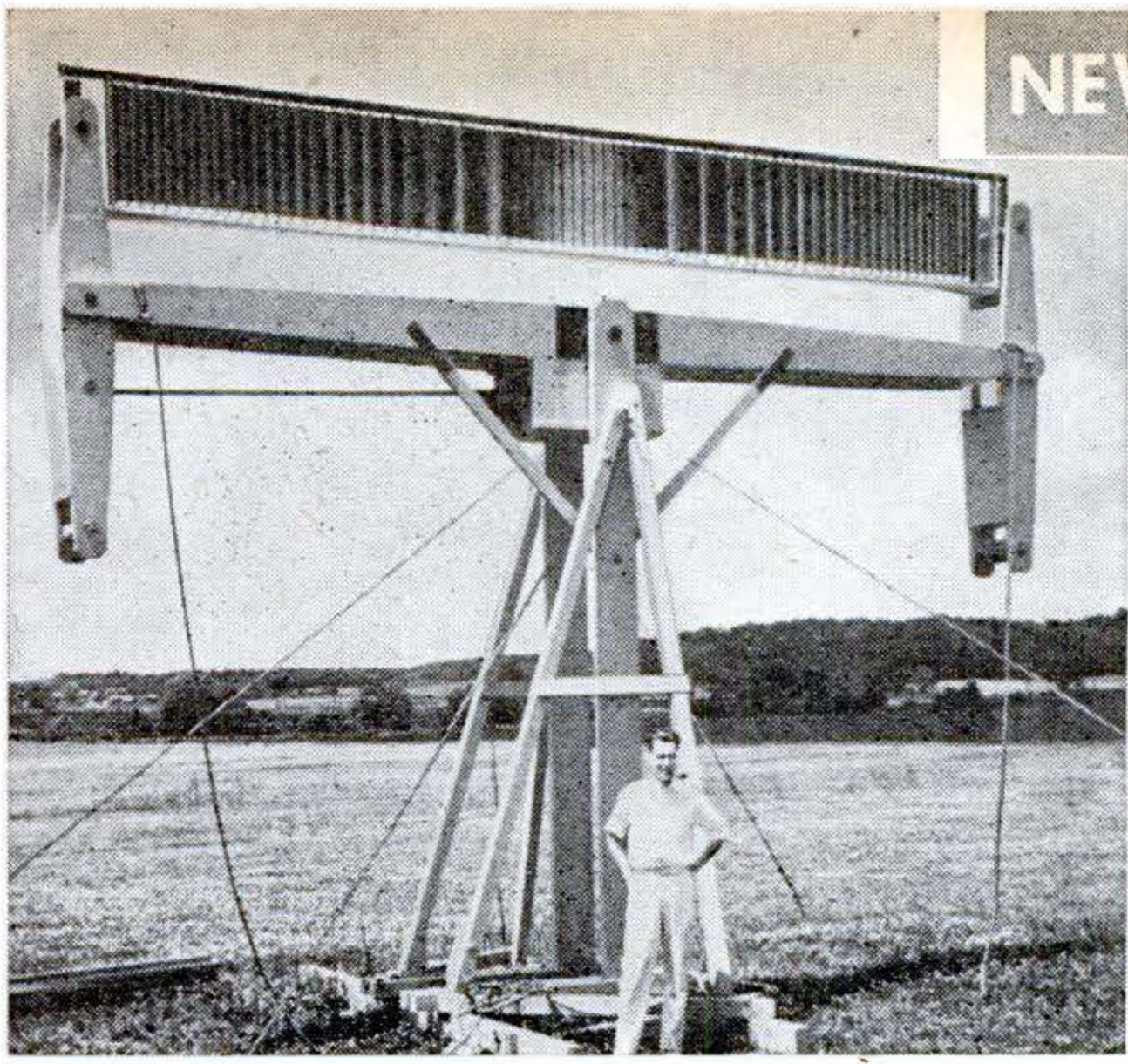
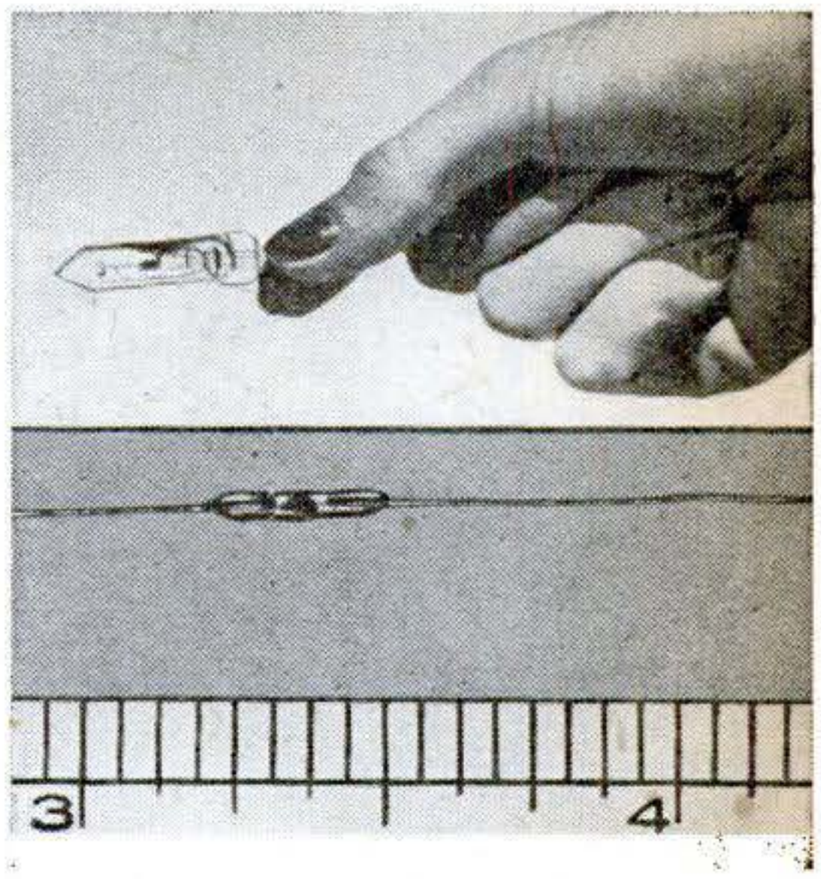
NEWS in ELECTRONICS



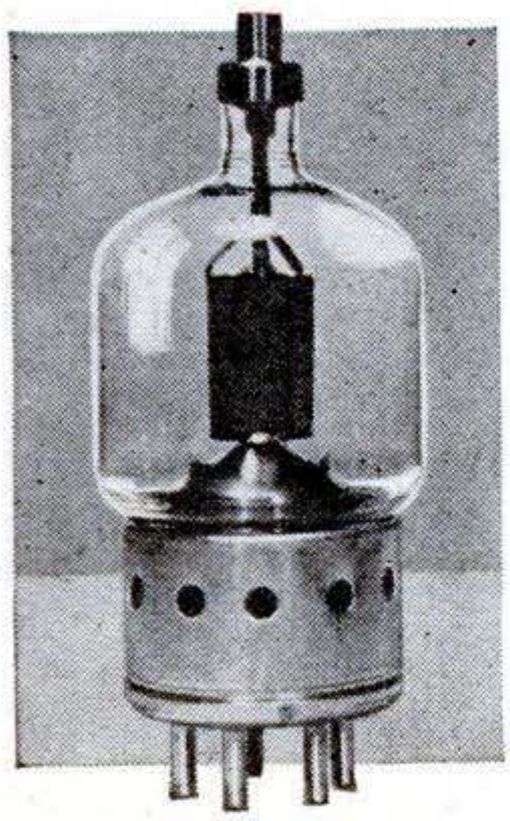


At left is a metal lens for focusing radio waves; above, a thermal resistor.

METAL LENSES will focus radio waves. With very short waves, this makes it possible to transmit maximum energy to a relay station instead of diffusing it broadcast. This 20′ Bell Laboratories lens-antenna, using metal reflectors, has produced radio beams only .1-deg. wide—probably the sharpest ever achieved. It is used as a test instrument.

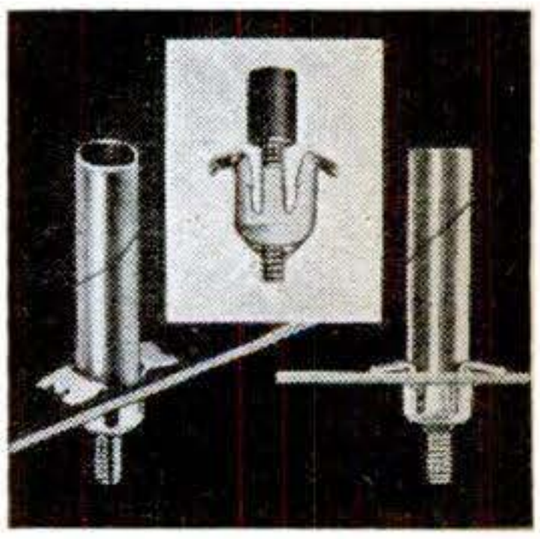
Another Bell development is the tiny thermal resistor that reacts to small temperature changes with large changes in resistance. When the image of a distant object is focused on it, temperature changes in the object as small as .001 deg. can be detected and electrically amplified. The device has been named the "thermistor."

A BEAM TETRODE, recently announced by Lewis Electronics, Inc., of Los Gatos, Calif., will help meet the demand for power-output tubes that can be used in high-frequency transmitters. The 150-watt AT-340 operates at full power up to 120 mc.



COMPLETELY AUTOMATIC in operation, the phonograph part of Philco's model 1201 phono-radio combination takes over as soon as you slide a record into the slot. No fumbling for the spindle or pickup arm is necessary. When either a 10″ or 12″ record is placed in the cabinet and the door closed, an automatic device centers, plays, and stops the disk.

FOR MOUNTING coil cores in radio chassis, Tinnerman Products, Inc., of Cleveland, offers the speed nut pictured below. The fastener quickly secures the coil to the panel, and allows accurate, vibration-free adjustment of the core screw. These nuts are being offered in sizes to suit several tube diameters and panel thicknesses.



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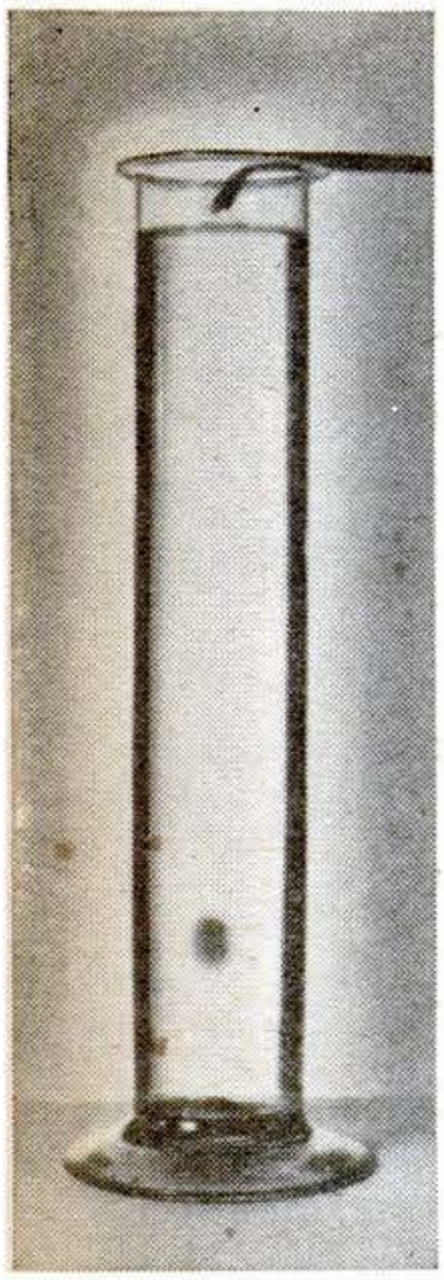
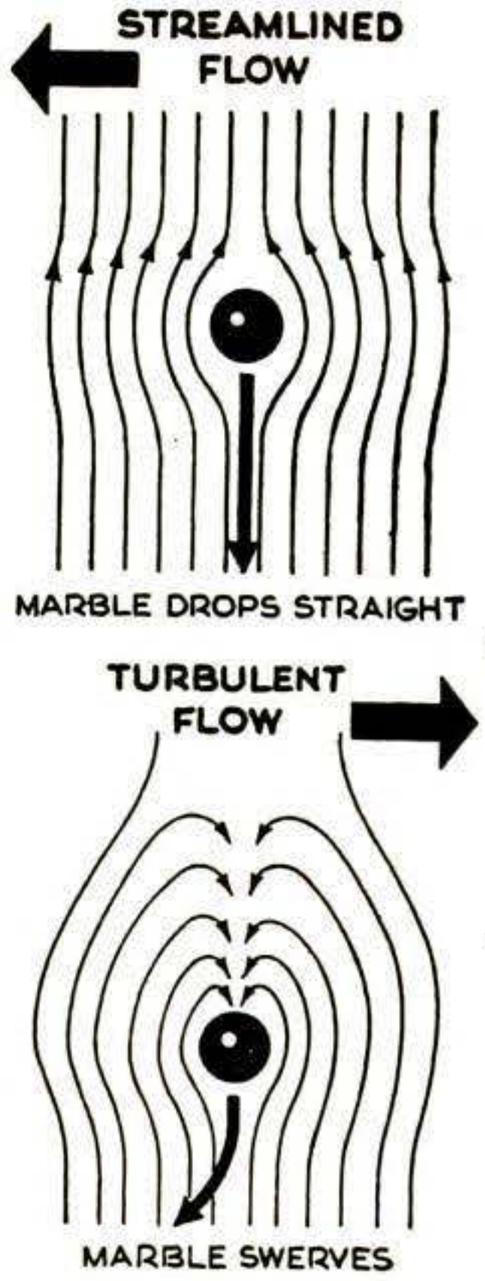
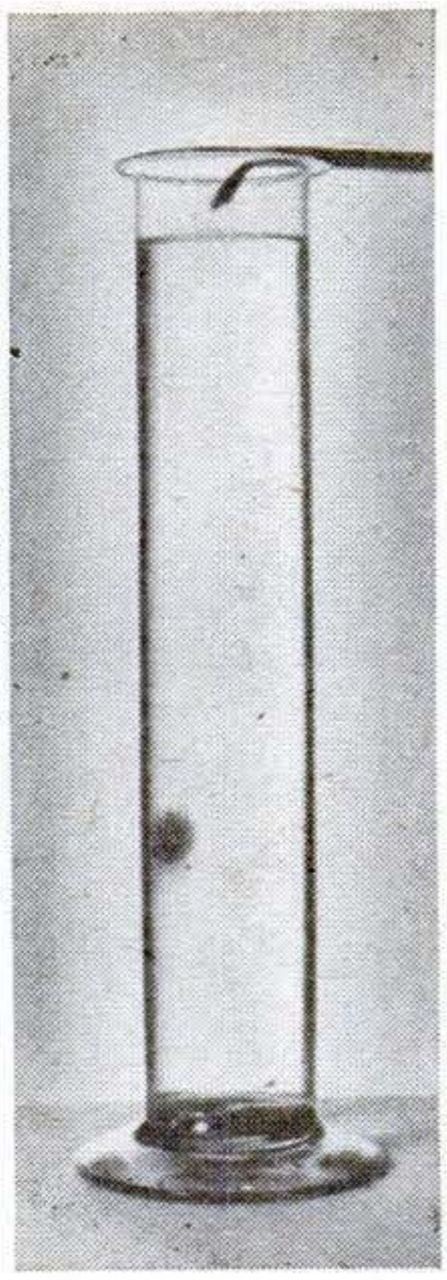
HOME EXPERIMENTS SCIENTIFIC





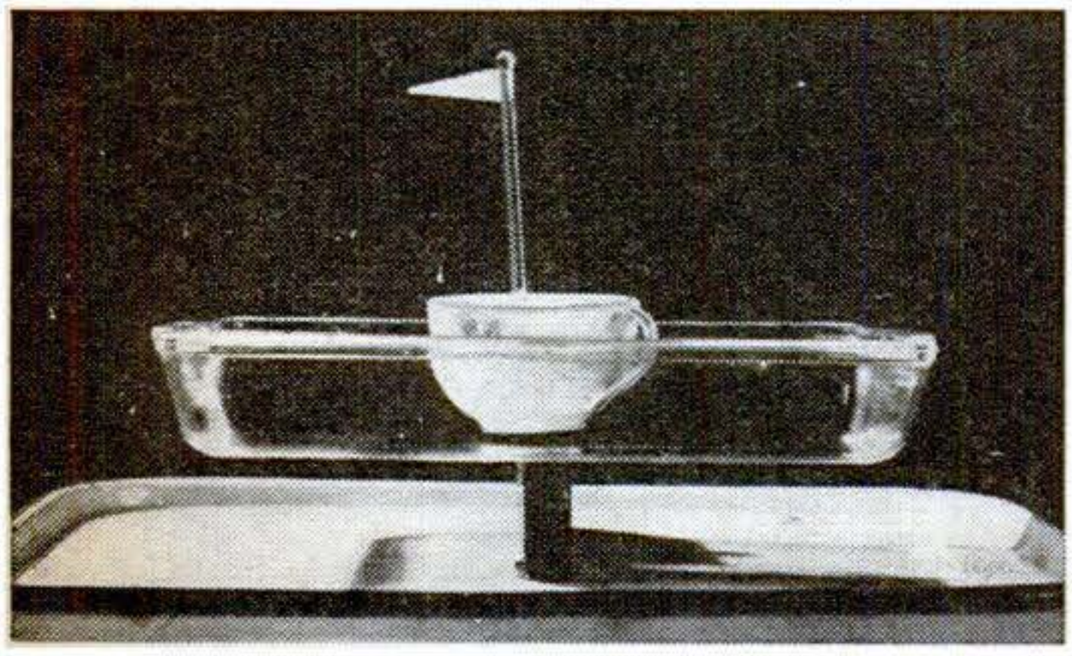


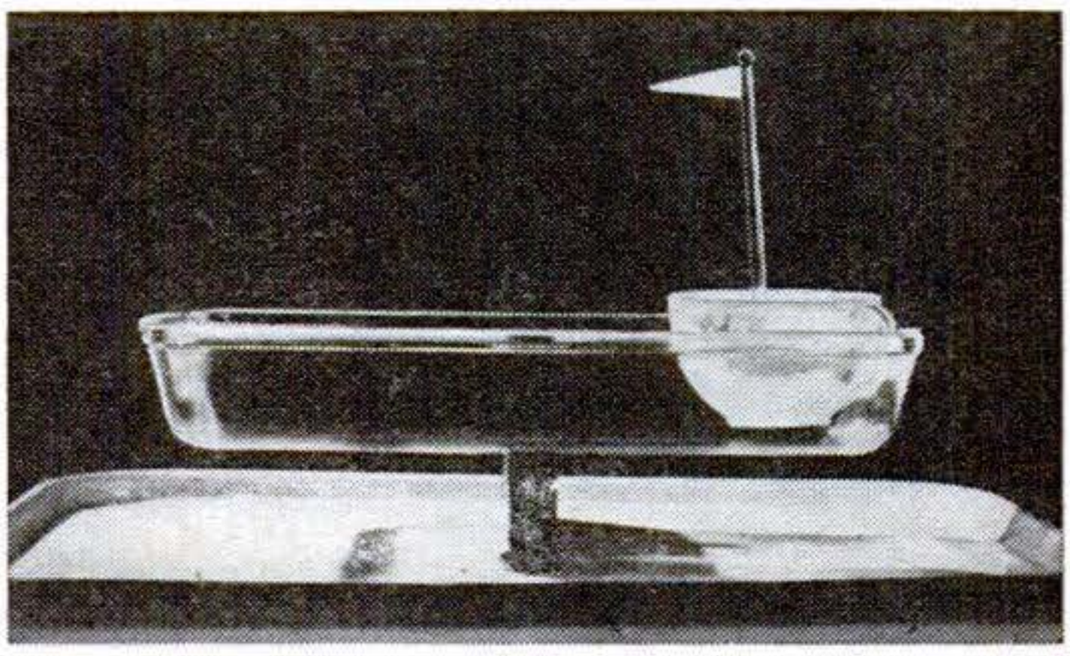
HANG A GLASS in a cup with a sling, below, so the glass does not touch the cup. Then twist the string and let go. The glass will spin as the string untwists and twists up again, and this will continue several times. Now add water to the cup and repeat. Because of the friction of the water, movement will be stopped, or *damped*, much faster. This shows how a liquid such as glycerin may be used in the casing of a magnetic compass to steady the needle.

DROP A MARBLE into a tall cylinder of some viscous liquid such as corn syrup or heavy mineral oil, as at the left above, and it will fall in a straight line. Then drop one into a similar cylinder of water, as at the right, and, almost invariably, it will swerve and hit the side of the cylinder.

Why the difference? In the viscous liquid, the marble travels so slowly that the liquid flows in streamlines around its spherical form. In the water, it falls so fast that the water becomes turbulent and these currents deflect the marble. This is one reason why planes and ships are streamlined.

FLOAT A CUP in the center of a tray of water balanced on a block of wood as shown below. If you now carefully push the cup to either end, will the tray topple over? Decidedly not! As you see at the right below, the tray remains balanced—although seemingly unbalanced—because the downward force exerted by the floating cup, equal to that of the water it displaces, is distributed through the water equally to all parts of the tray. But weight the cup so it sinks—and the tray will topple over, for the downward pressure becomes greater than that of the water which is displaced by the cup.





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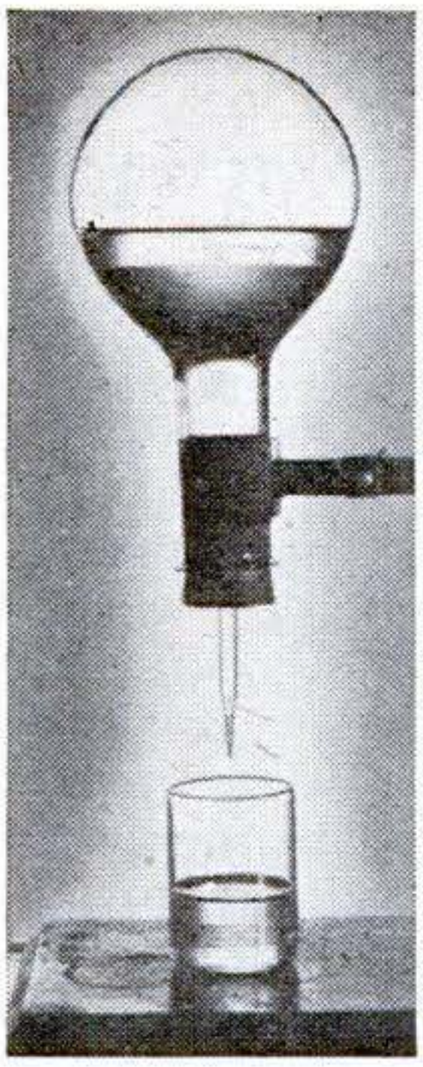
PARADOXES shown with common fluids



MOUNT A BOTTLE as at the left after partly filling with water and fitting with a stopper that has a glass tube drawn to a jet. The result is an improvised barometer that responds to differences in pressure between the air inside and out. When the outside pressure is falling, the air inside expands, causing drops of water to drip from the glass tube. When the outside pressure is increasing, bubbles of air rise through the tube to equalize that inside.

WATER FLOWS more rapidly from a short tube inserted into a container than from a plain hole with a diameter equal to that of the inside of the tube. In the case of the plain hole in the nearer can below, the momentum of the converging water is aimed at the axis of the jet. As a result, the jet narrows temporarily just outside the hole—this narrow point is called the *vena contracta*—and the effective size of the hole is lessened. When a tube is added, the water follows the tube and the jet does not narrow.

PLACE TWO GLASS TUBES, both of the same length but one three or four times the diameter of the other, through holes in a cork so they extend to the bottom of a bottle of colored water. Install a bent tube with one end just through the cork, and blow into it. Except for a slightly greater height in the small tube due to capillary attraction, the water will rise to the same level in both. The height of a column of liquid is determined solely by pressure, not by the cross-sectional area of the column.

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Antennas for the New F.M. Band

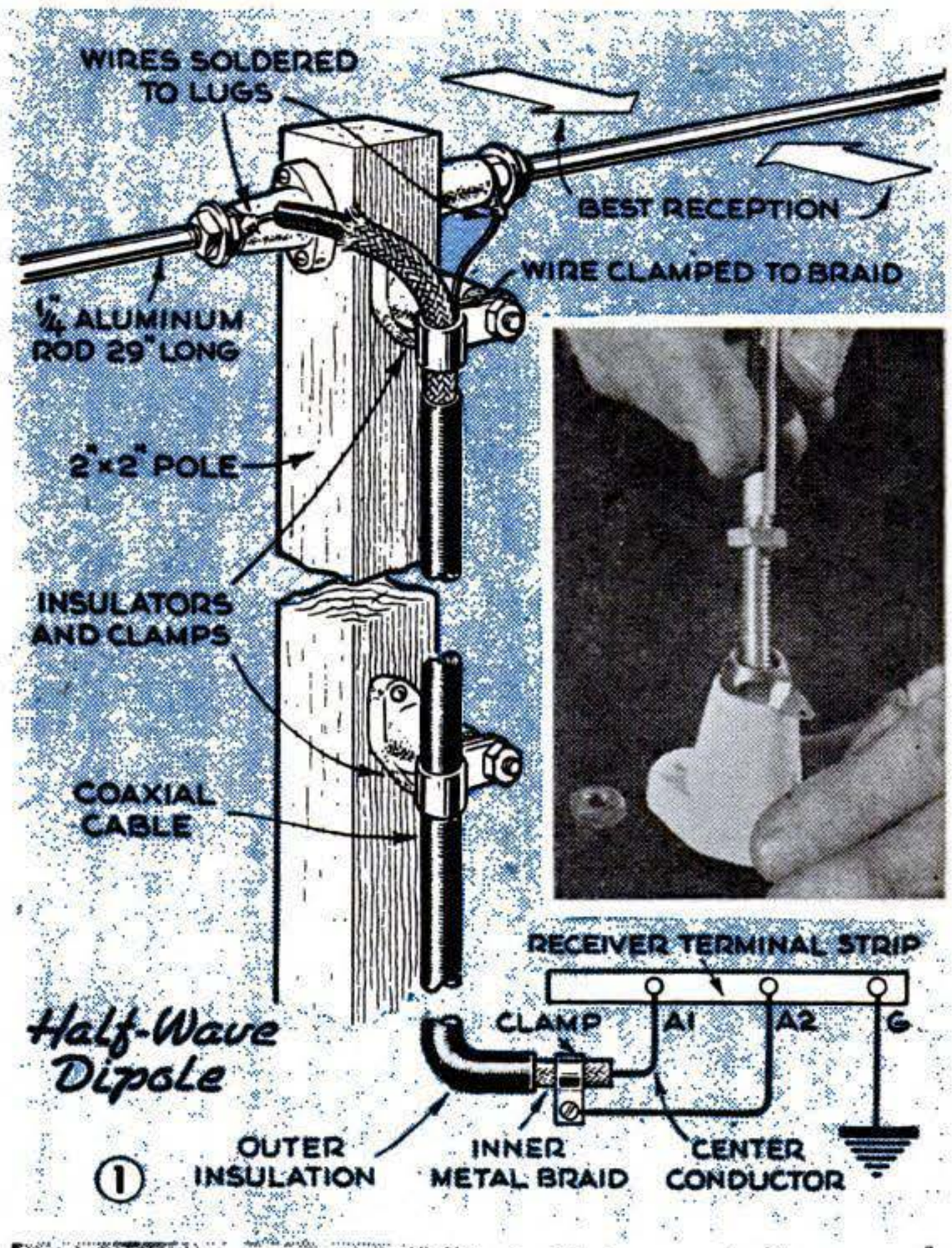
WHEN CHANGING YOUR RECEIVER TO HIGHER FREQUENCIES, DON'T FORGET TO BRING YOUR ANTENNA UP TO DATE, TOO

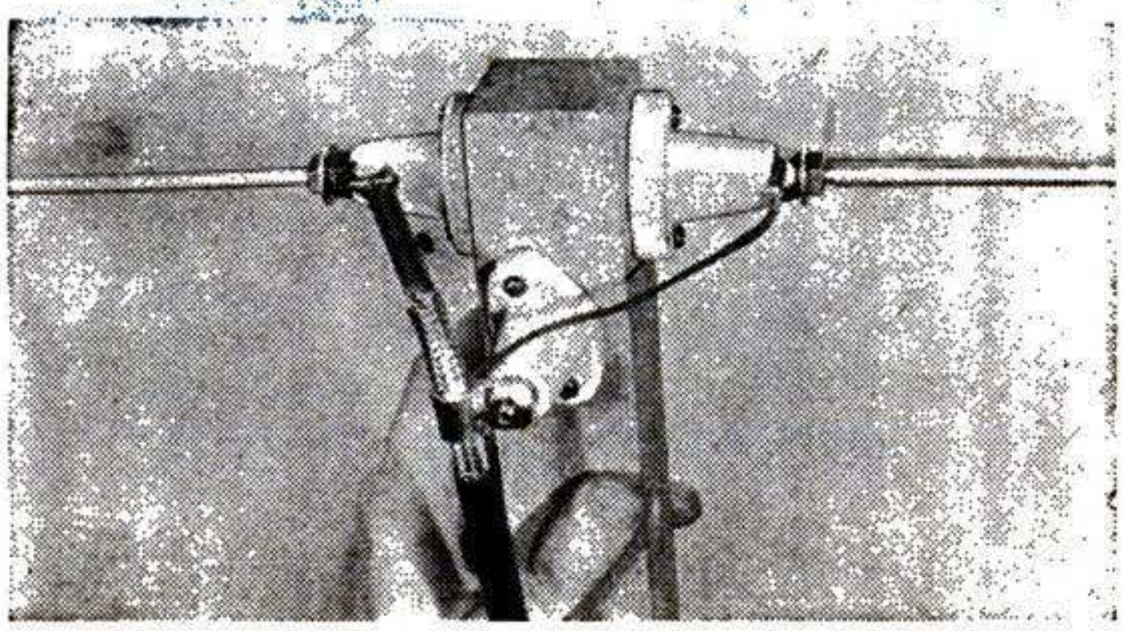
By Tracy Diers

FREQUENCY MODULATION is moving upstairs in the radio spectrum. The Federal Communications Commission has shoved F.M. out of its old home in the 42- to 50-megacycle band. While the slow moving operation takes place, F.M. continues to sprawl indecisively at two locations. But the future address of static-free reception has been definitely decided: write it down as 88 to 108 mc.

For all but the most recent F.M. listeners, this means that some changes will have to be made in receiving equipment. You may have your set rewired, use a converter, or buy a new radio. In any case, good reception demands that your antenna fit the frequencies it is supposed to receive.

That goes for all types of F.M. antennas, but when it comes to making a particular choice, you also want to take into account such factors as elevation, neighboring buildings, distance from transmitters, and strength of the signal in your location. If you live close to a broadcasting station, you'll find the





For best results the half-wave dipole should extend at least 10′ above the roof of a building. Fig. 1 shows how the antenna is connected to a typical receiver terminal strip. You can use other types of low-loss feeders in place of the coaxial cable. If you do, connect one wire of the pair to each of the dipoles, and one to each of the first two terminal posts. This directional antenna favors signals coming from the directions shown by the blocked arrows.

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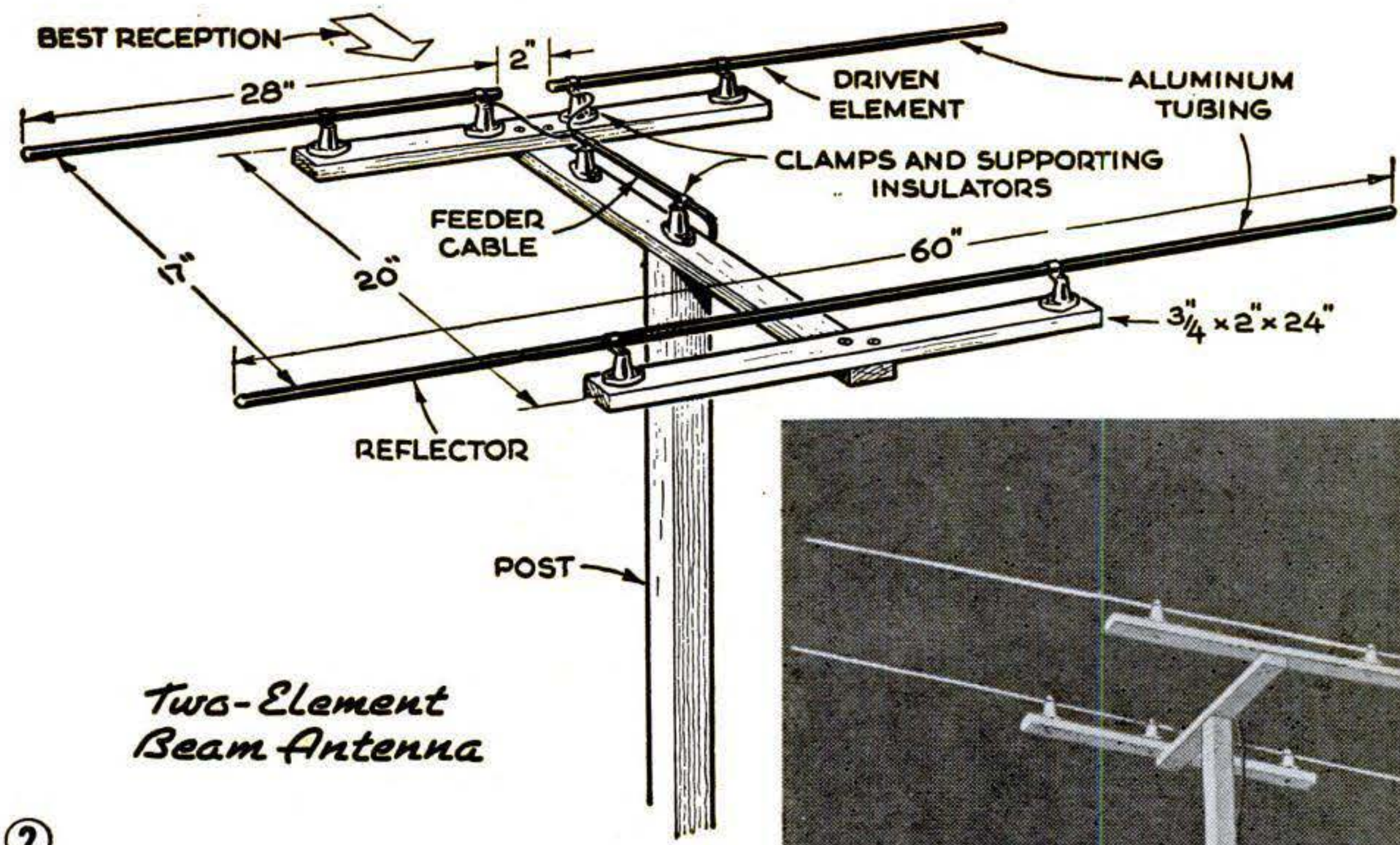
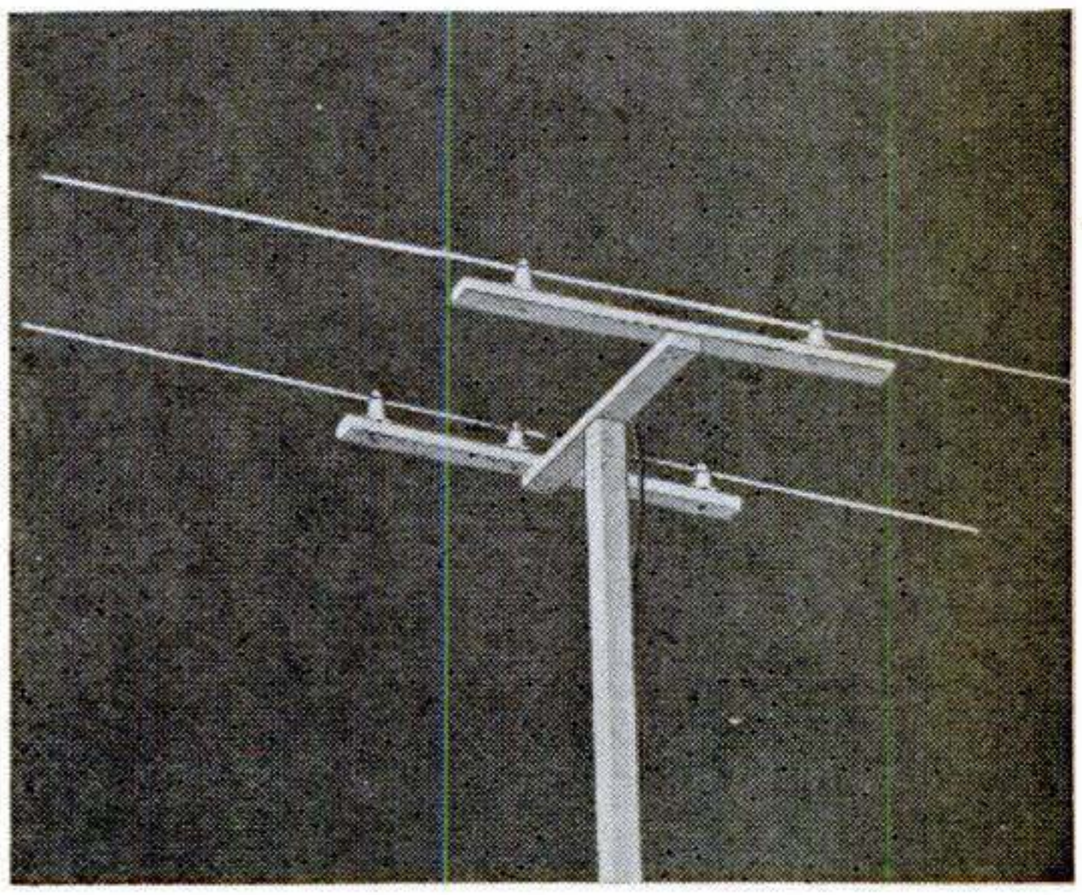
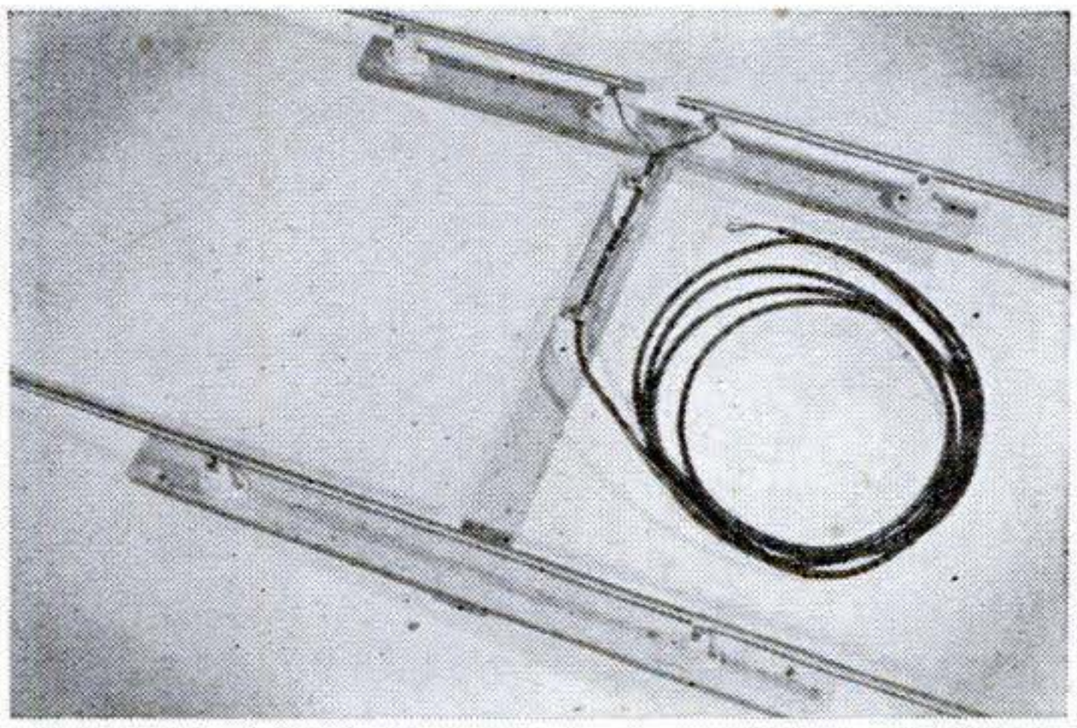


Two-Element Beam Antenna

②



As can be seen in the drawing above, the two-element beam antenna consists of an ordinary half-wave dipole, now called the driven element, and a reflector. The latter has no connection.



A two-conductor feeder cable is illustrated in the photo at the left. One conductor is soldered to each element; the other ends go to A1 and A2.

easily constructed half-wave dipole efficient.

The dipoles are made of ¼" aluminum rod. After cutting them to length, thread one end of each ¼"-20 and clamp with two nuts into an insulator as shown in Fig. 1. Mount the insulators on opposite sides of a 2" square wooden pole. Several types of feeders, or connecting wires, may be used between the dipoles and the receiver.

Most high-frequency antennas must be correctly aimed for best performance. To position your antenna, rotate it slowly while a helper tunes the receiver and signals to you when all stations can be heard with greatest clarity and volume.

Farther from the center of a service area, an antenna must be more sensitive to pickup from the chosen direction, and capable of cutting off noises from the rear. The two-element antenna above is designed for that job. It can be made of aluminum rod or tubing from ¼" to ¾" in diameter.

Transmission lines generally drop off in efficiency as a result of age and weather. While coaxial cable is quite durable, many F.M. listeners feel that it is too expensive, especially when the receiver is located at any great distance from the roof. You can make a low-cost, long-lasting feeder line of ordinary No. 14 enameled copper wire, but to link it to the antenna, you will need a simple Q-matching transformer that is nothing more than two vertical legs. The combination is the half-wave antenna, open-wire line, shown in Fig. 3. Bend two aluminum tubes and bolt them to standoff insulators through 3/16" holes drilled in the tube walls. The vertical portions of the tubes must be perfectly parallel, and spaced 1¼" from center to center. Accuracy of the Q-matching depends on this distance.

Simplicity and low cost are among the advantages of the single-wire fed half-wave antenna illustrated in Fig. 4. Although it is

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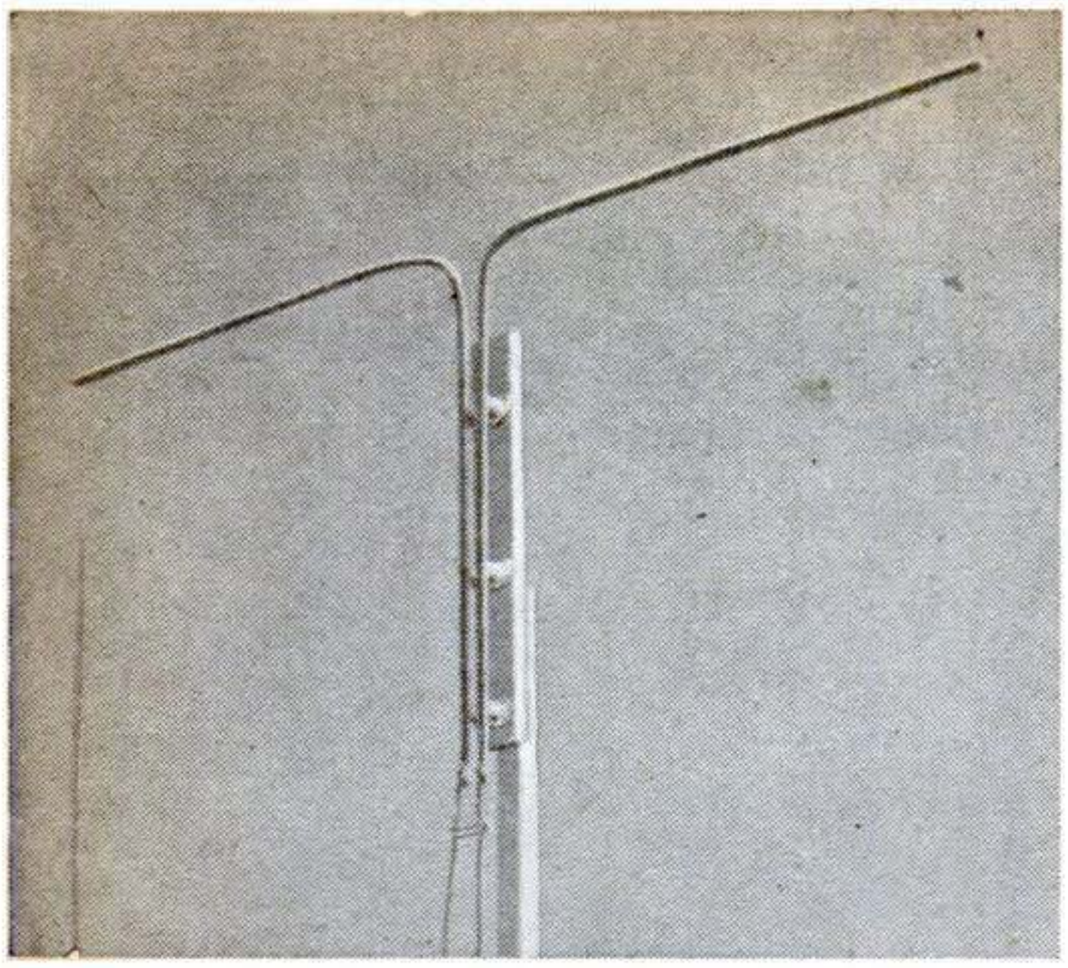
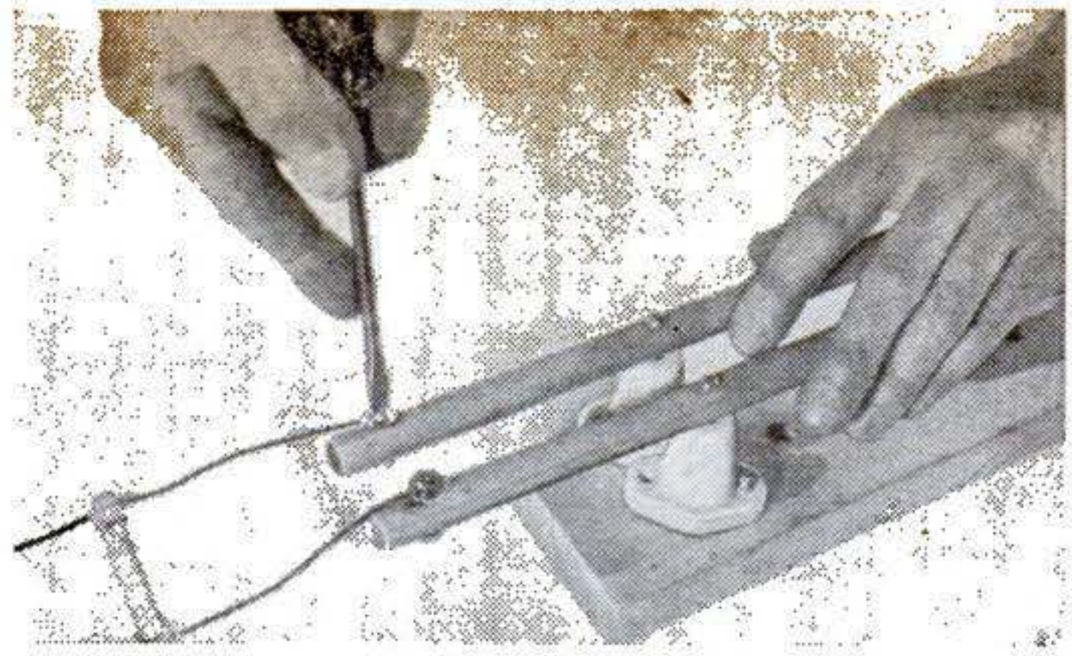
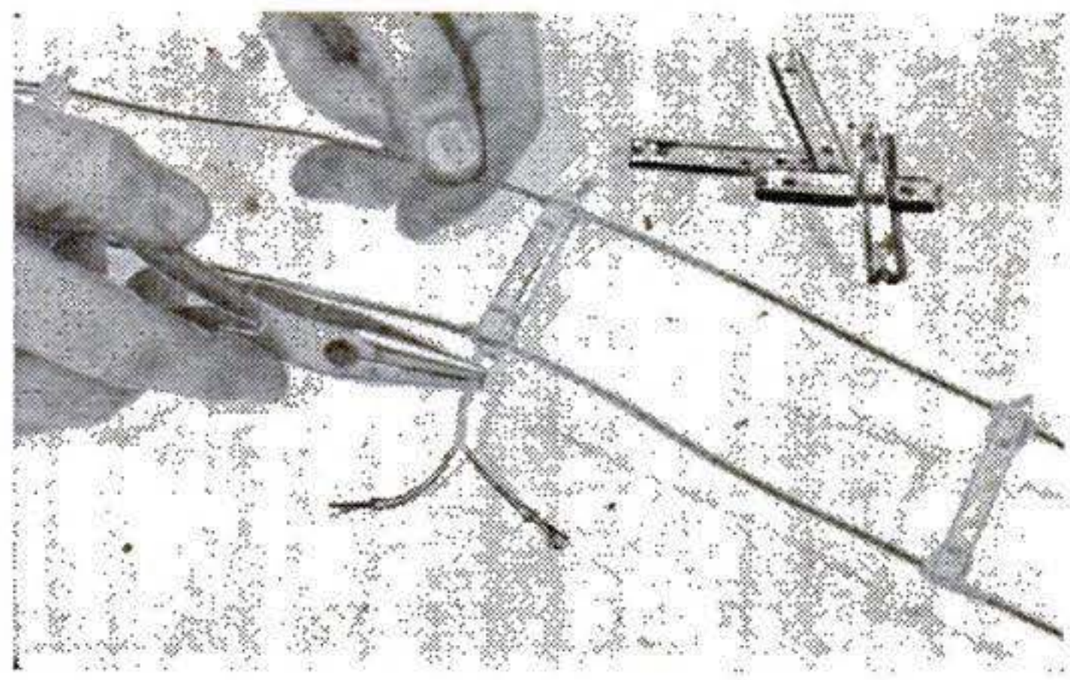
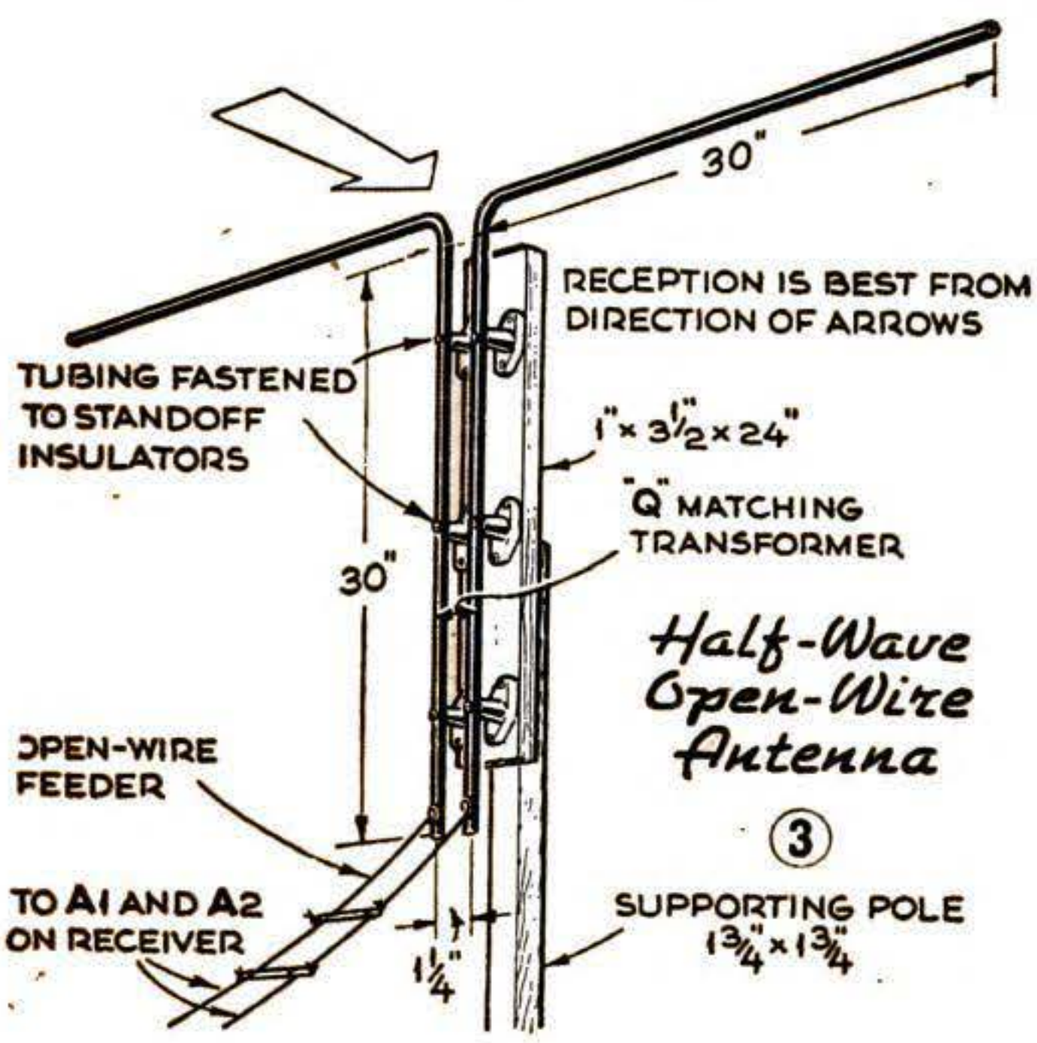




The half-wave open-wire antenna is constructed from two 5′ lengths of ½″ aluminum tubing. Make a smooth right-angle bend at the midpoint of each tube to form the Q-matching transformer.

Space the open-wire line with a sufficient number of 2″ plastic spreaders. Use insulators to keep the line from touching the building on the way down.

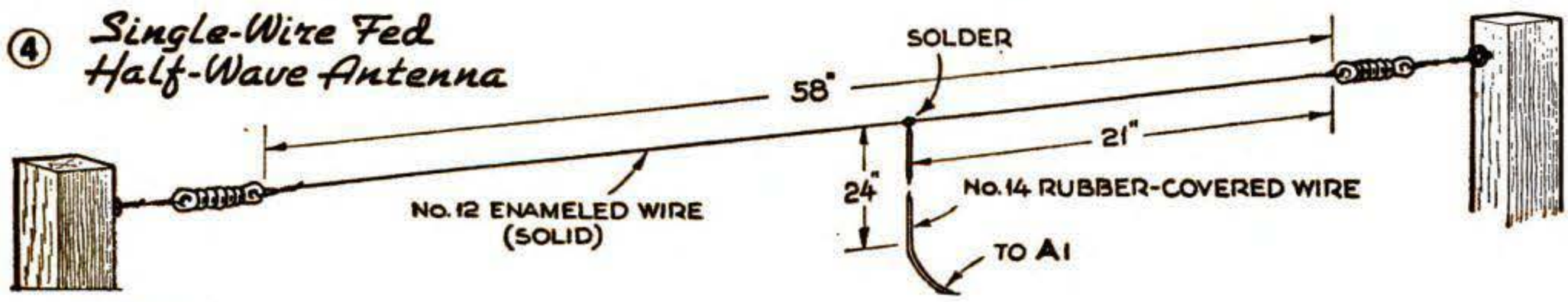




not the most efficient type, it is quite satisfactory in areas where signal strength is high and interference low. The feed line, made of ordinary rubber-covered lead-in wire, must leave the antenna at right angles for a distance of at least 2′, and a slightly different method is needed to couple the single line to the receiver terminal strip. Connect the feeder to either A1 or A2, and put a jumper across the other two posts.

The open-wire fed V (Fig. 5) is a country antenna in two ways: if you live far out in the suburbs or country, you may need a rig with great directional sensitivity; if you're far enough out to need it, you may have enough space to build it in. Each leg of the "V" stretches 96½′ from the central post, but if your premises won't allow such spaciousness, you can cut the legs to 48¼′ each. Use No. 14 enameled copper wire for the feed line, and keep it short by locating the post as near the receiver as possible. It is important that the "V" embrace the direction from which the distant signal is approaching.

The most fortunate F.M. listeners are those located near a number of transmitters. For them, any of the following will be satisfactory. Requiring very little space, and no directional adjustments, the coaxial-fed half-wave vertical antenna on page 199 is made



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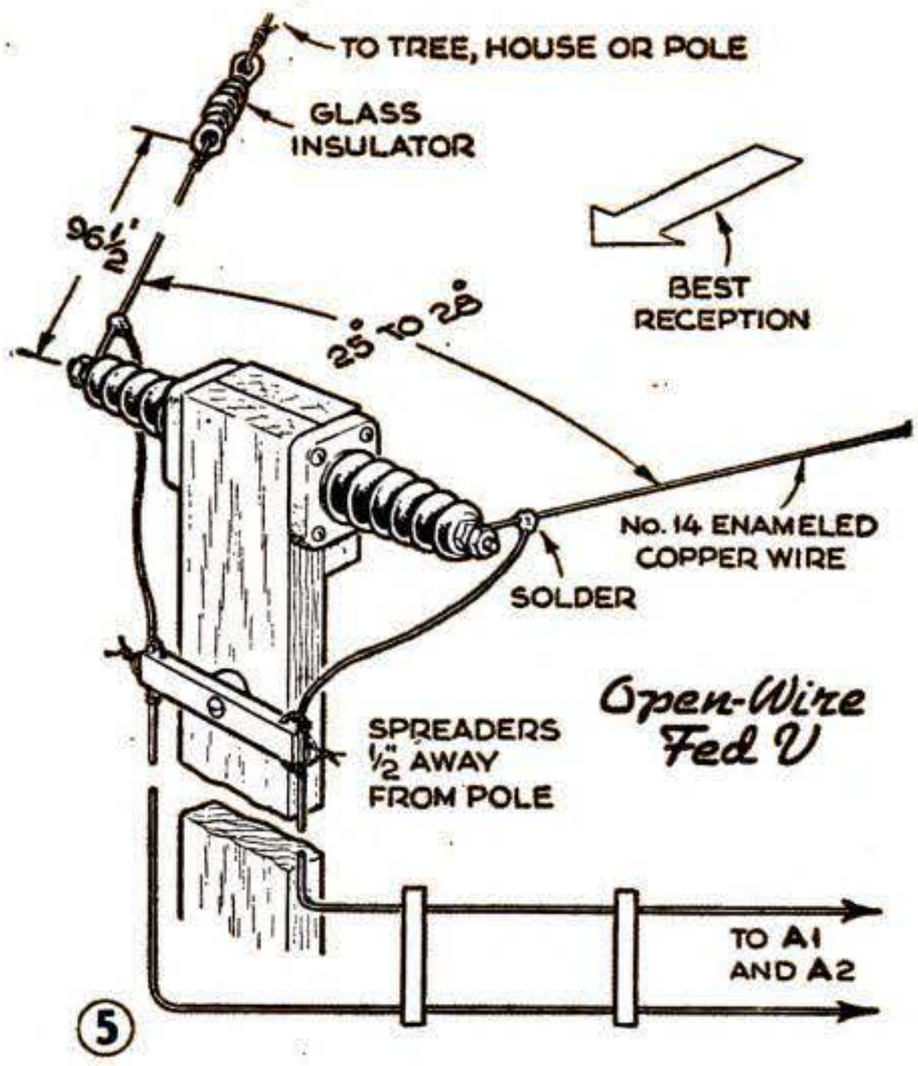


Open-Wire Fed V

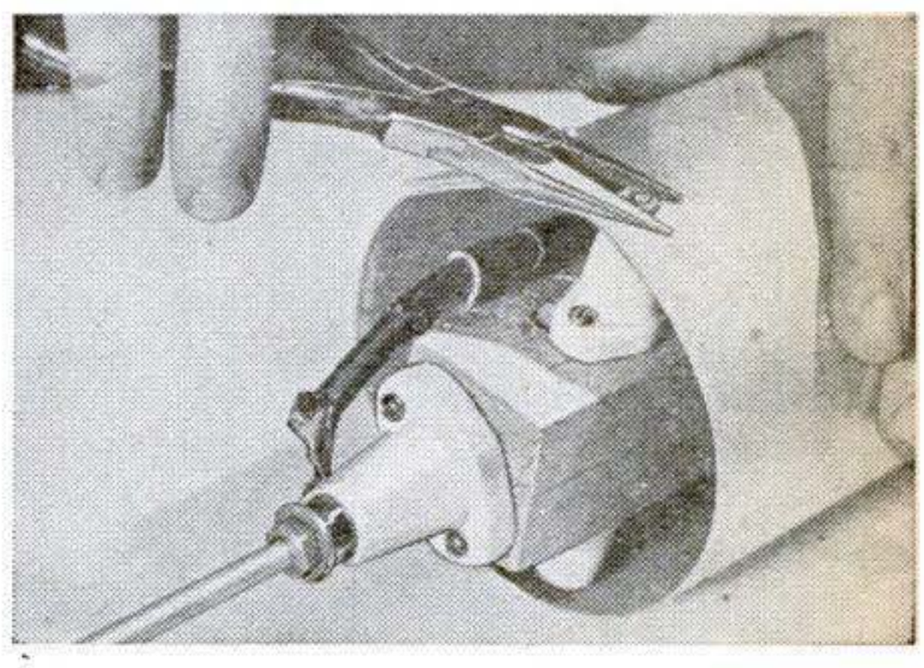
from a 29″ length of ¼″ aluminum rod. One end of it is clamped into an insulator, which is fastened with screws to the top of a 1½″ by 1½″ post about 35″ or 40″ long. Solder the center conductor of a length of coaxial cable to the insulator lug, and fasten the cable along the length of the pole with tubular clamps and standoff insulators.

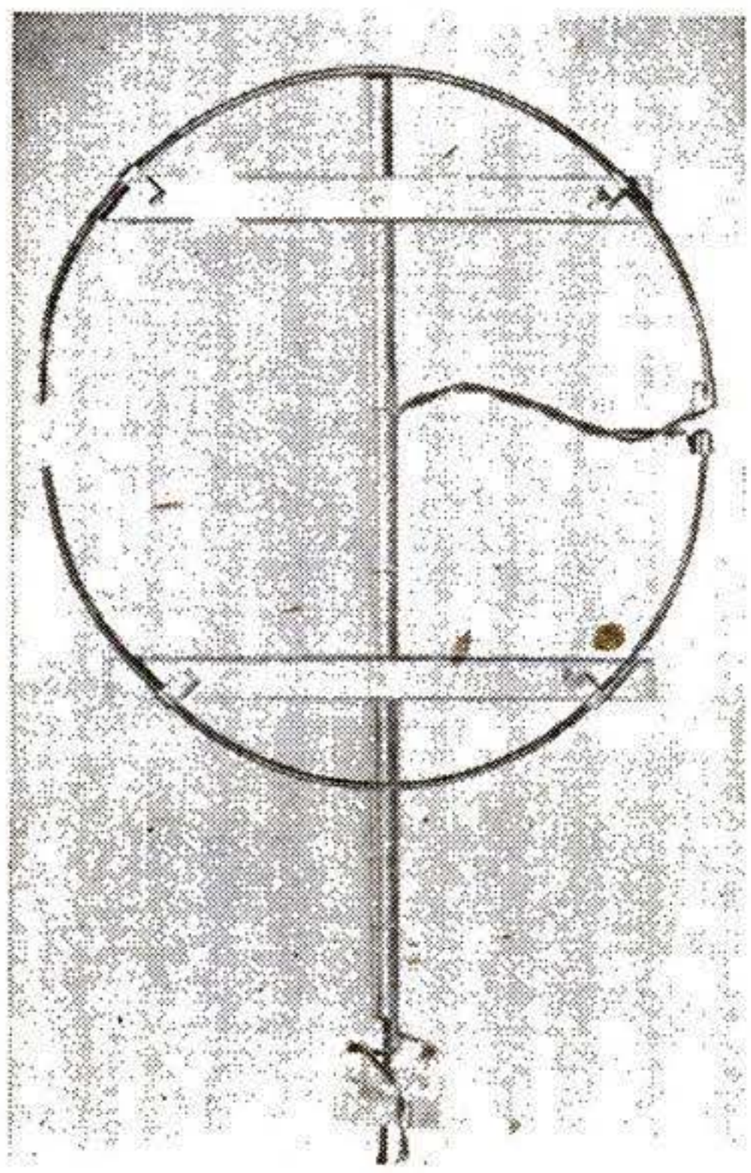
Next, roll a sheet of aluminum 1/32″ by 14″ by 29″ into a 4″ by 29″ cylinder and bolt the edges together. Drill holes to coincide with the locations of the standoff insulators, and fasten the cylinder with nuts to the tops of the insulators.

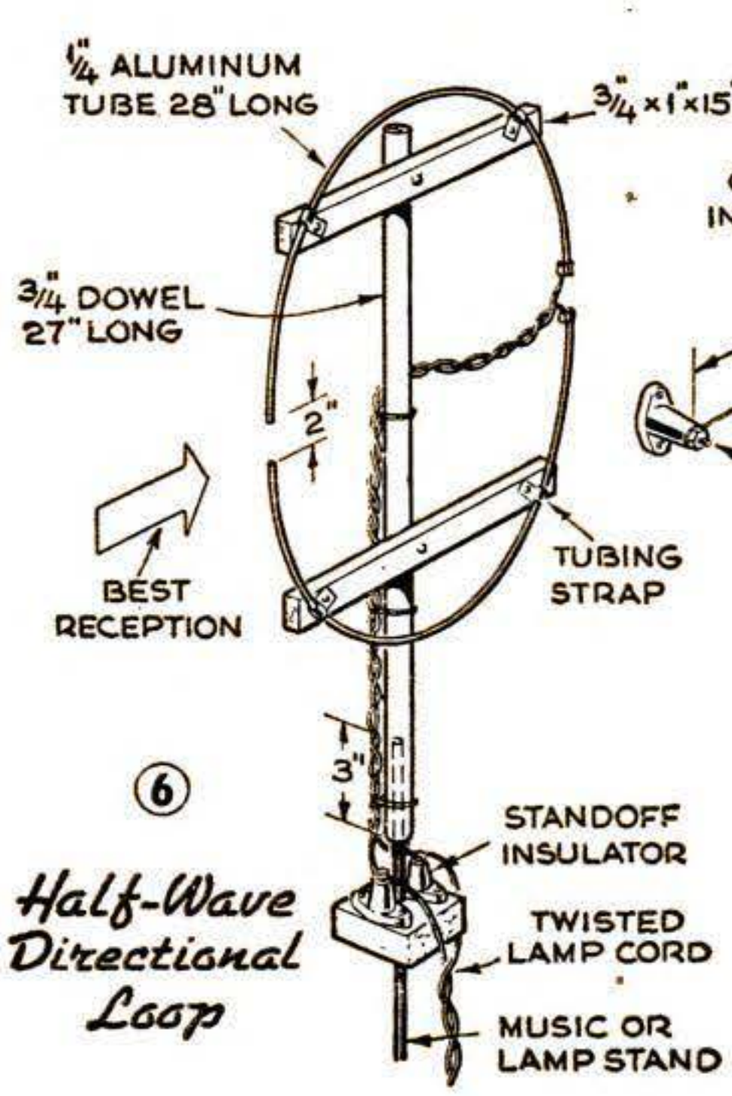
One of the most satisfactory indoor antennas is the half-wave directional loop (Fig. 6), since it can readily be turned to favor any station. Drill a hole 3″ in one end of the dowel, and make the diameter of the hole large enough to allow a free fit on top of a music or lamp stand. Twisted lamp-cord feeders are clamped to the ends of the aluminum semicircles. Keep the feeder line under 12′ in length.

If the decoration of your home calls for a less conspicuous type of indoor aerial, there is the fixed-position indoor half-wave antenna, shown in Fig. 7. The bell wire can be concealed along the baseboard or molding, or behind a drape. If any choice of position is possible, make tests to find which is best.

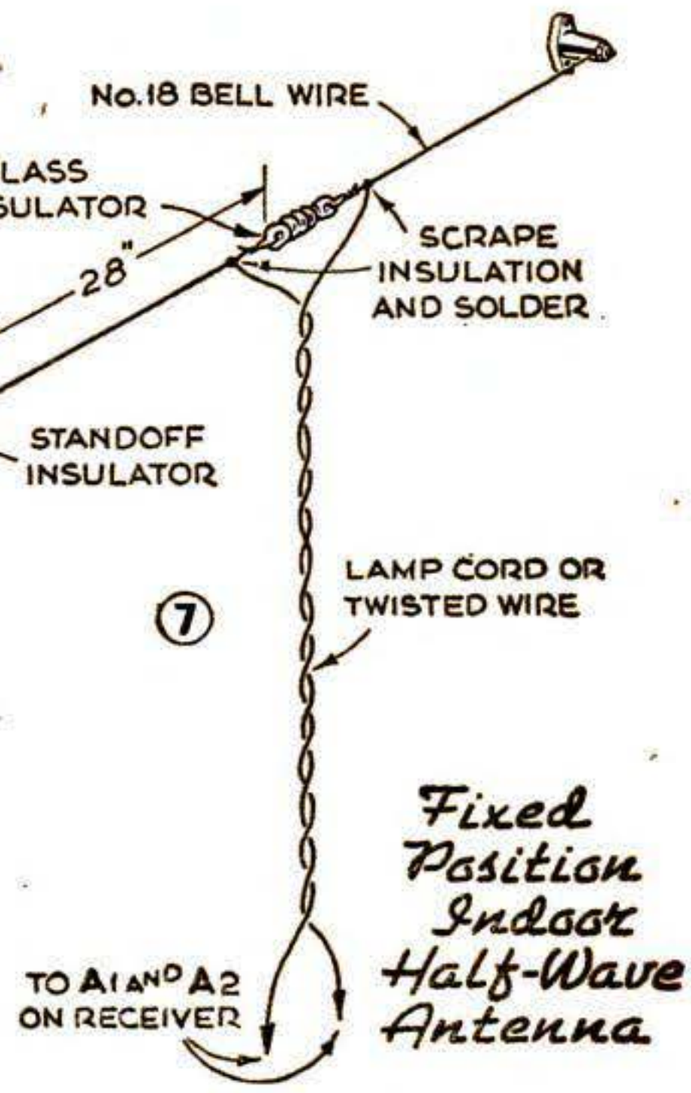
The shield of the coaxial cable should make contact with the aluminum cylinder. A piece of wire inserted between the clamp and the top of the cylinder is recommended.







Half-Wave Directional Loop



Fixed Position Indoor Half-Wave Antenna

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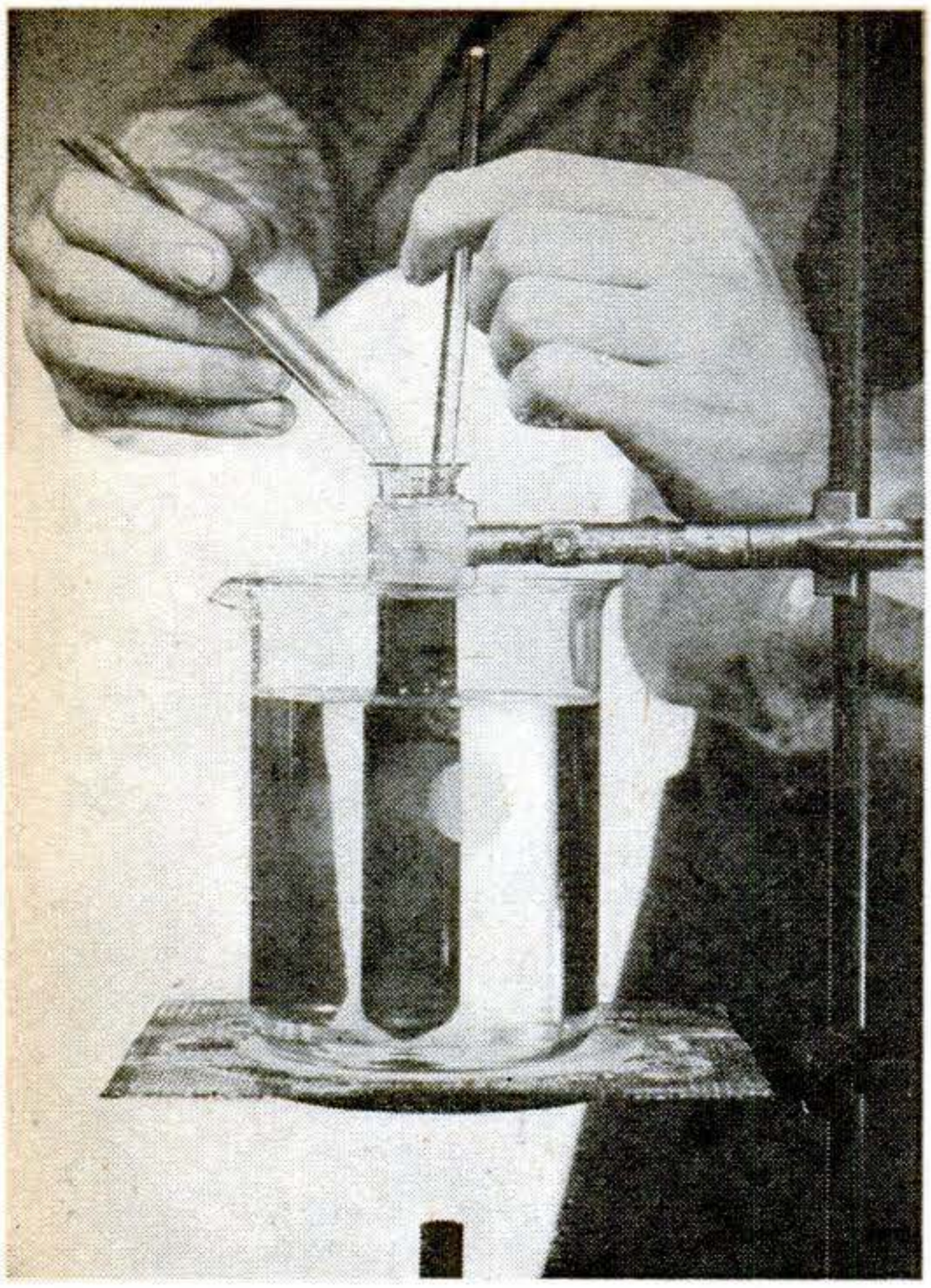
Chemistry

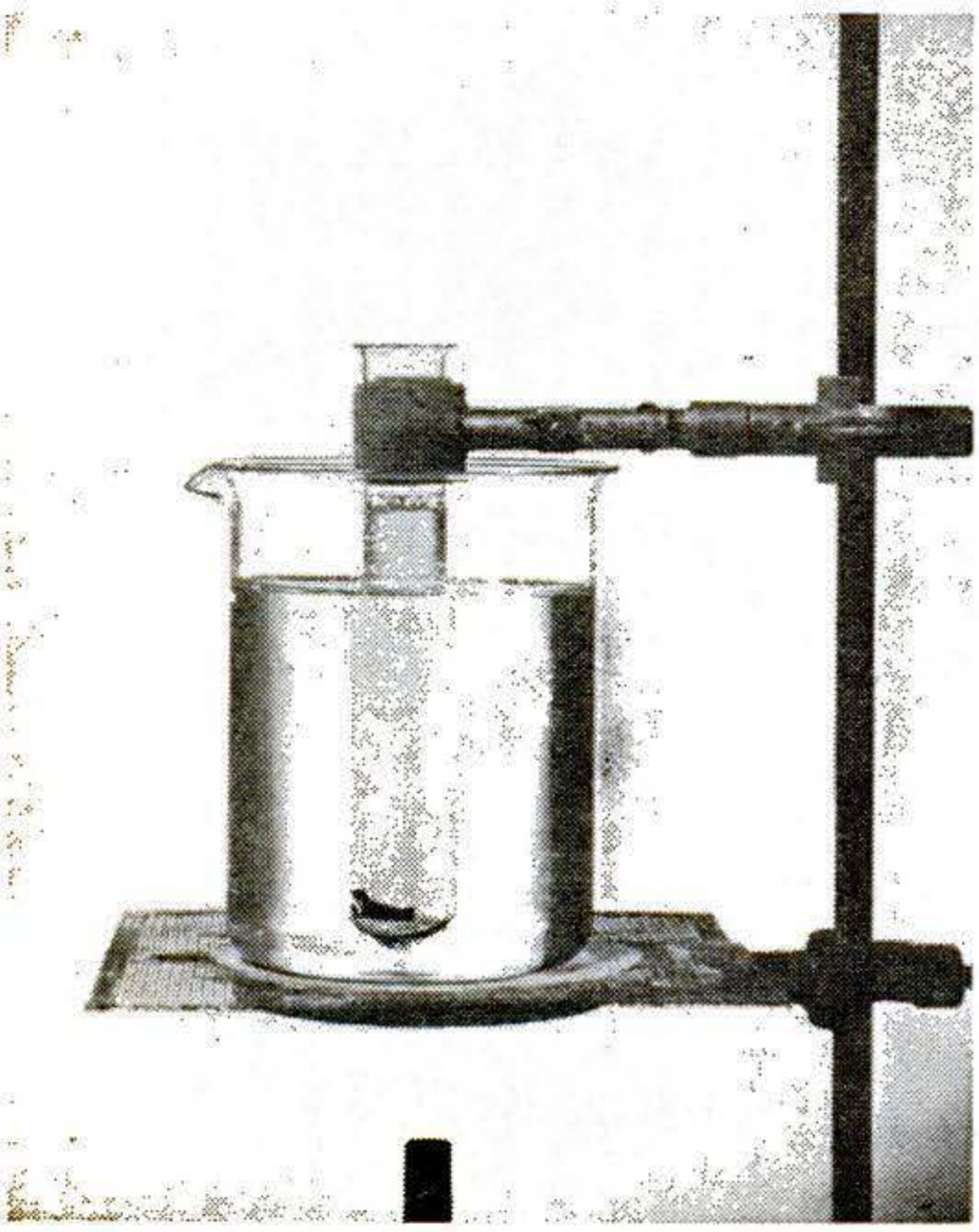
Dyes from modern laboratories give us a choice of any color under the sun for our clothes.

By KENNETH M. SWEZEY



1 Synthetic indigo, an important dye, is a blue powder which, by itself, does not dissolve in water. But it does in warm water containing a little sodium hydroxide and sodium hyposulphite.

2 In the process, the hyposulphite takes oxygen from the indigo, changing it to a colorless or yellow compound that dissolves easily. The mixture should be kept at 50 deg. C. for one half hour.



FEW CHAPTERS in the history of chemistry are more romantic than the story of dyes. Long before he could write, prehistoric man had learned to stain his body and dye his garments with juices extracted from plants and insects. Wrappings on Egyptian mummies buried before 3000 B.C. show clearly the blue dye of the indigo plant and the red of the madder root. A secretion that the ancients obtained, drop by drop, from a tiny mollusk found on the shores of the eastern Mediterranean yielded the famous Tyrian purple, a dye so expensive that it long was the badge of royalty.

All of the early dyes were laboriously obtained from plants, certain insects and mollusks, and a few minerals. Those few that did not fade from washing or sunlight could be counted on the fingers of one hand.

A great step forward came in 1856. Working in an attic laboratory in his London home, William Henry Perkin, an 18-year-old chemistry student, in that year stumbled upon the treasure of coal-tar dyes. His discovery revolutionized the dye industry.

At the time, Perkin was trying to synthesize quinine from aniline oil, a secondary substance which is produced from the messy black tar left as a waste product when coal is burned for gas and coke. Instead of white crystals of quinine, he got an ugly mass of a sticky dark substance. When he tried to rinse it from the test tube, the mass surprisingly dissolved into a beautiful purple solution.

This result intrigued Perkin and he did not rest until he had found the reason. His purple, or violet, solution soon was named "mauve." It eventually became the foundation of the coal-tar dye industry. Within a few years chemists had synthesized magenta. Then came synthetic alizarin, madder's chief coloring principle, and synthetic indigo. Today there are more than 5,000 coal-tar dyes.

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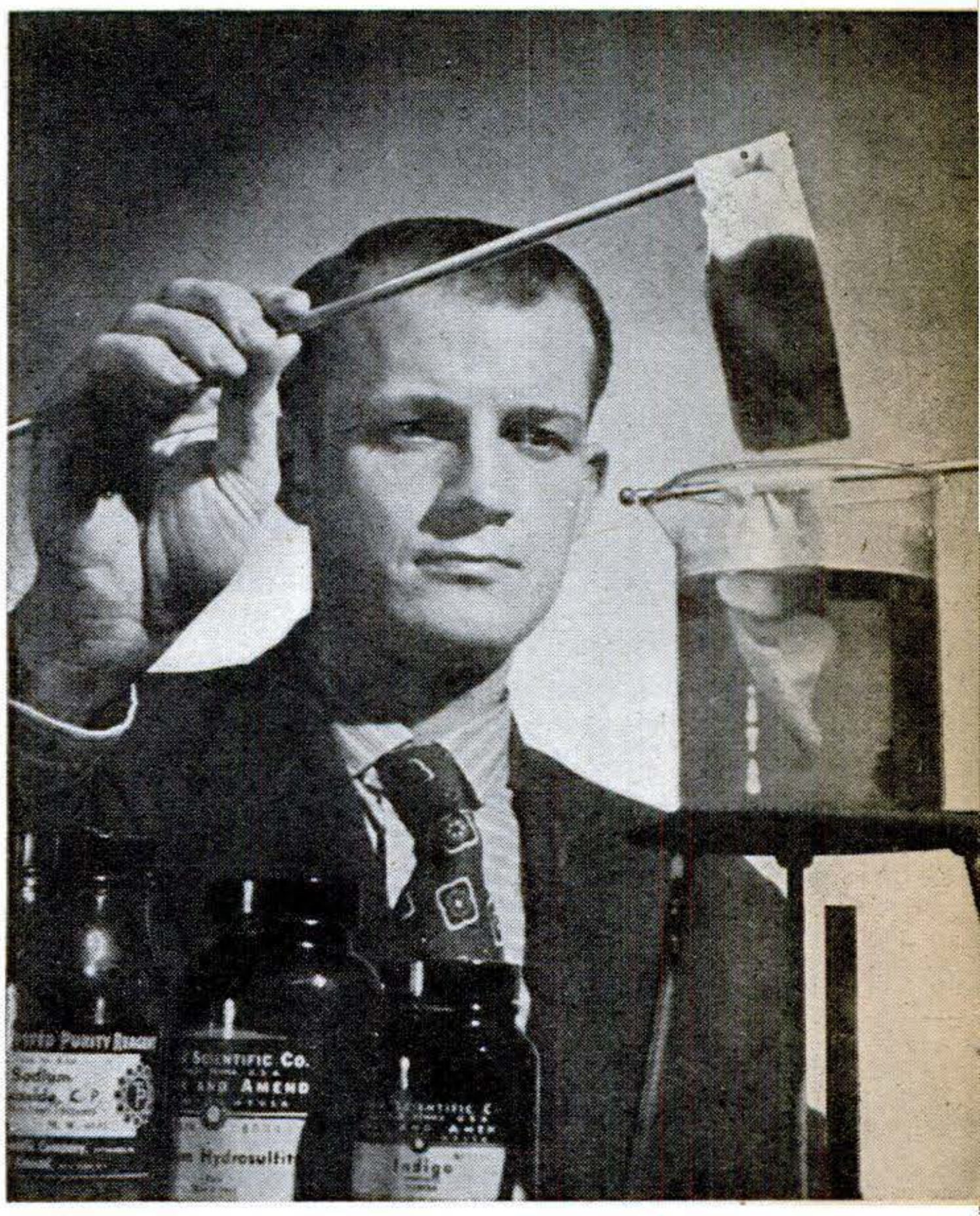
ROBS THE RAINBOW

Any colored solution is not necessarily a dye. To serve as a dye, the solution must penetrate a textile or other material and deposit its coloring matter so firmly in the fibers that handling and washing will not remove it. To be really "fast," the color also must not fade or change after prolonged exposure to light and air.

The simplest to use are "direct" dyes, those which attach themselves directly to a textile either by chemical reaction with the fiber or by mechanical adhesion. Many vegetable dyes and most packaged synthetic dyes are of this type.

Many of the most permanent synthetic dyes, however, are developed directly in the textile fiber by means of a few amazing tricks of chemical sleight-of-hand. Indigo, aniline black, azo colors, and mineral dyes all make use of this magic.

With a few grams of indigo and some sodium hyposulphite, you can demonstrate the production of what is undoubtedly the best inexpensive blue dye ever made. Sodium hyposulphite is known as sodium hydrosulphite in the dyeing trade and should not be confused with sodium thiosulphate, the "hypo" used in photography.



3 White cotton remains white as long as it is submerged in the diluted solution. But remove it, and, as the indigo regains oxygen from the air, the cloth becomes blue.

As purchased, indigo is a dark-blue powder or paste that is insoluble in water. To make it soluble, it must be reduced (that is, de-oxidized) to a colorless compound. For your demonstration, mix 2 grams of powdered indigo with 1½ grams of sodium hydroxide dissolved in 5 ml. of water in a test tube. Then stir in an additional 20 ml. of water and support the tube in a water bath heated to 50 deg. C. When the solution is heated, stir it well and slowly add 1½ grams of sodium hyposulphite.

Let this mixture stand for about half an hour, keeping the temperature constant and stirring occasionally. At the end of that time, the blue indigo should have changed to a yellow or colorless "indigo white."

Indigo is called a vat dye because in days gone by the color was reduced and made soluble by a fermentation process in huge tanks or vats. Today hyposulphite takes the place of these ferments. You can prepare an experimental "vat" by adding a few grains of hyposulphite to 250 ml. of water in a beaker and heating the water to 50 deg. C. After 10 minutes, add the contents of the test tube. The solution should now be pale yellow and clear.

Now for your magic. Dip a white cotton cloth into your vat and let it remain for a minute. As long as it is submerged, the cloth stays white. But lift it out and in a minute it turns blue. Repeated dipping and exposure darken it.

What happens is this: By reaction with the oxygen of the air, the de-oxidized colorless

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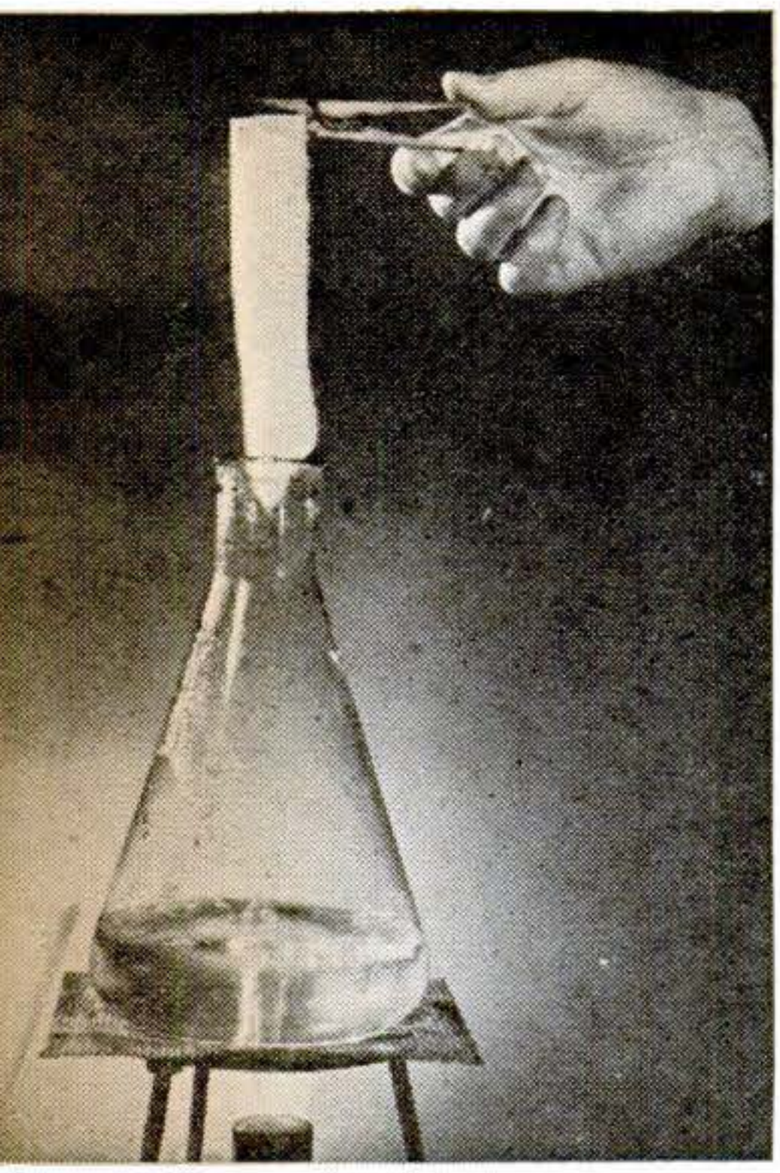
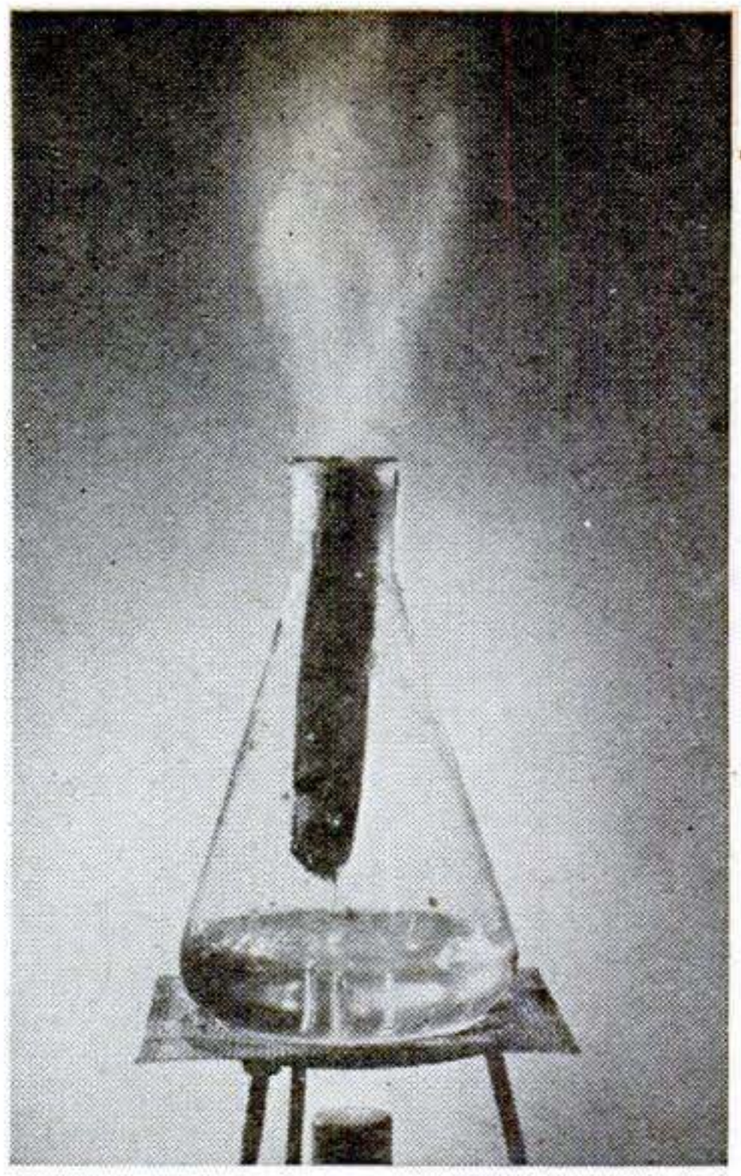




Dip a cloth in a colorless solution of aniline hydrochloride and copper sulphate (extreme left), put it in steam, and it is dyed aniline black.

indigo saturated through the cloth is changed back into indigo of the original color. Because indigo is insoluble, washing will carry away only the little that is attached loosely to the surface. The remainder is bound permanently to the fabric.

Another important and extremely fast coal-tar dye is aniline black, developed directly in the cloth by the oxidation of aniline. This oily liquid yields dyes of every hue of the rainbow, but aniline itself is colorless. Be careful in handling aniline, for the fumes and the liquid are poisonous. If you spill any on your hands, rinse them with water immediately.

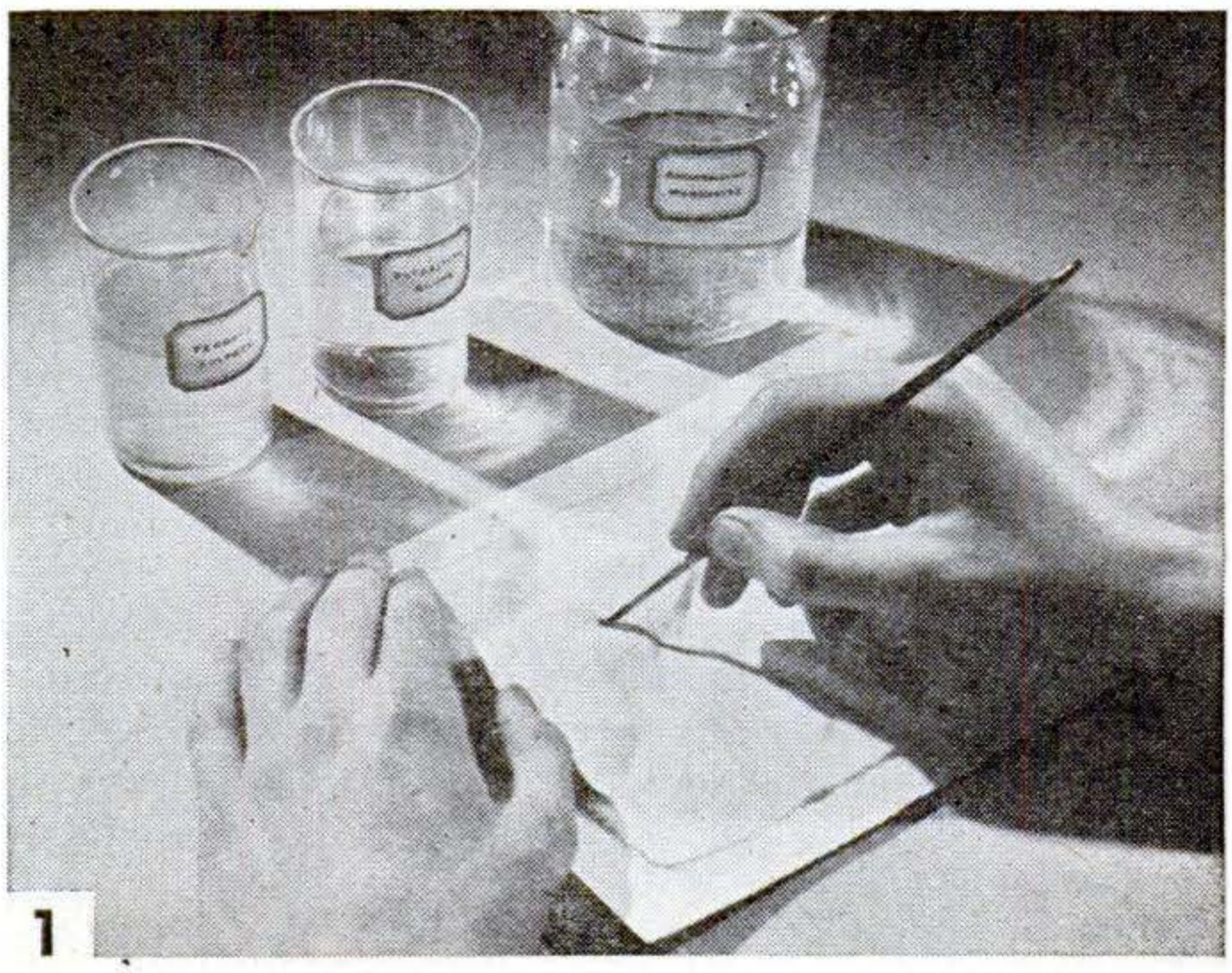
Prepare some aniline hydrochloride by adding 3 ml. of concentrated hydrochloric acid to 2 ml. of aniline in a small beaker. Dissolve the resulting crystals by adding 10 ml. of water. To this solution add 3 grams of potassium chlorate, as an oxidizing agent, and 1 gram of copper sulphate to serve as a catalyst.

Soak a strip of white cotton cloth in this solution for several minutes. When you remove it, it still will be white. But blot off the excess solution and suspend the strip in a flask in which water is boiling, and the cloth will quickly change to black. The heat and moisture of the steam hasten the oxidation of the aniline.

Several excellent mineral colors, considerably older than coal-tar dyes, also are made by precipitating an insoluble chemical directly into a textile. Chrome yellow, a brilliant color, is a good example.

In one glass dissolve ½ gram of lead acetate in 25 ml. of water, and in another ¼ gram of potassium bichromate in an equal amount of water. Dip a strip of cotton in the first solution, remove it, blot off the excess solution, and dip in the second. Yellow lead chromate is precipitated into the cloth. Repeat the process and the color becomes deeper. You can also produce the bright orange of basic lead chromate by passing the dyed cloth quickly through a boiling solution of calcium hydroxide.

Another widely used mineral color is iron buff, the basis for some khaki dyes. This is really iron rust deliberately precipitated into a textile. You can produce the color by dipping a cloth successively into three colorless solutions. First pour 100 ml. of water into each of three glasses. In the first, dissolve 2 grams of ferrous sulphate; in the



1

One dye will produce several colors if used with substances known as mordants. As a test, paint a design on a cloth with two mordants (1).

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These four solutions, all of which are colorless, will produce either iron buff or Prussian blue, two of the most important mineral dyes.

second, 5 ml. of concentrated ammonium hydroxide; in the third, 10 ml. of 5-percent sodium hypochlorite solution.

Now dip your strip of cloth, blotting it between dips. The ammonia will change the ferrous sulphate into green-gray ferrous hydroxide. The hypochlorite in turn oxidizes this into brown ferric hydroxide, which, when dry, changes to the oxide.

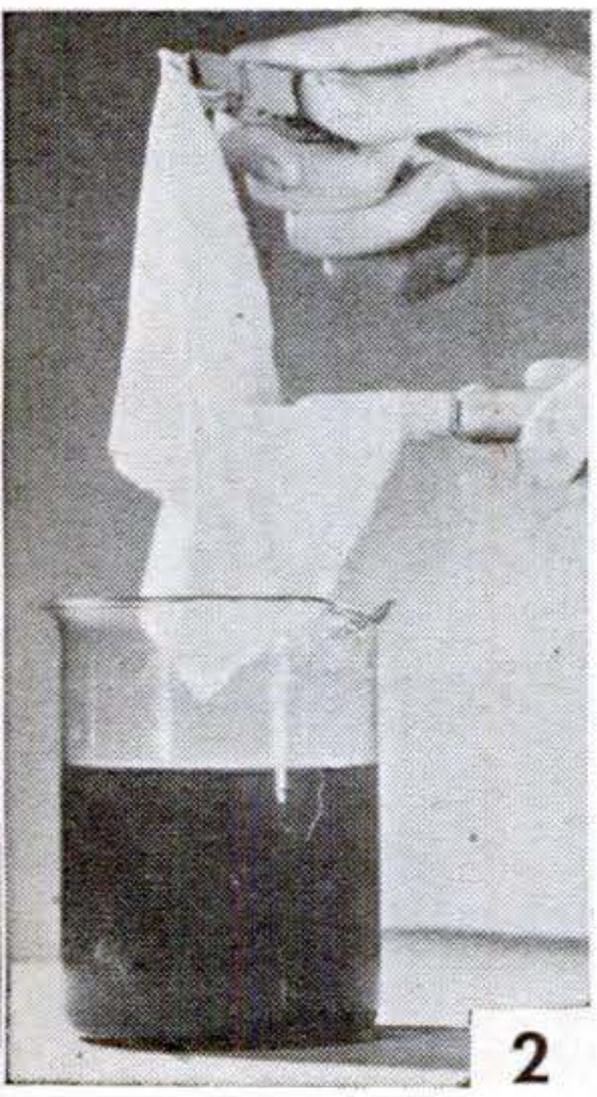
You can also change your iron buff into Prussian blue. Dip the dyed cloth into a solution of 1 gram of potassium or sodium ferrocyanide and 20 drops of hydrochloric acid dissolved in 100 ml. of water. This solution itself will be colorless, but when the buff-dyed cloth is taken out it will have changed to an attractive Prussian blue.

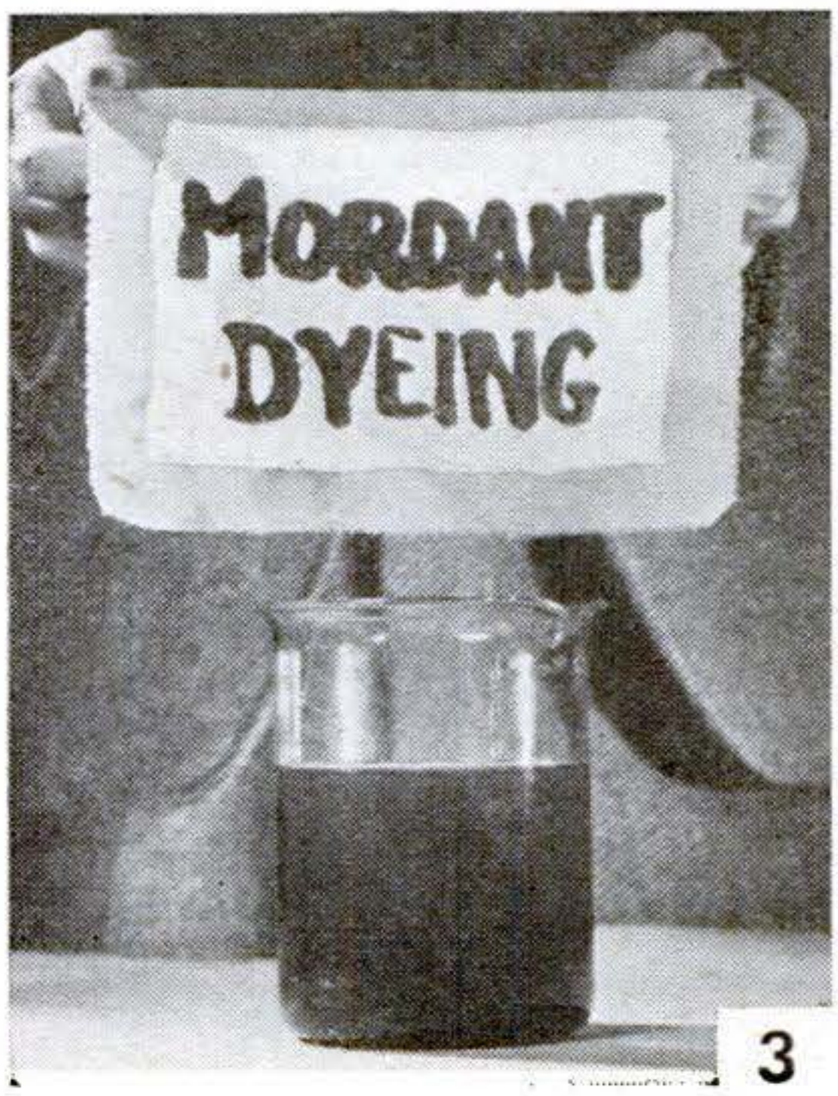
Many dyes fail to attach themselves strongly to certain textiles, but they can be forced to do so by first treating the textiles with colorless insoluble compounds called *mordants*. These usually are metal hydroxides which cling to the textile fibers and either absorb or react chemically with the dye. When a chemical reaction takes place, the resulting color is called a "lake" and may be entirely different from that of the dye. Designs of different colors sometimes are produced with a single dye and different mordants.

You can show this by painting part of a piece of cotton cloth with a solution of ferrous sulphate, such as that used in the iron buff experiment, and another part with a similar solution of potassium alum. Leave a third part of the cloth unpainted.

Blot off the excess solution, dip for a minute in a solution of ammonium hydroxide, blot once more, and immerse for 10 minutes in a 2-percent suspension of alizarin red dye in water. When the cloth has been removed and rinsed, you will find that the part mordanted with the alum will remain a bright orange-red, that the area mordanted with iron will be a dark red-brown, while the part which was not mordanted at all will remain practically colorless.

Thus, it can be seen, from these few experiments, how far dye chemistry has progressed from the natural indigo and madder of the ancients. Modern chemistry is constantly robbing the rainbow of all of its colors to give us the varied hues in our textiles that most of us now accept just as a matter of course.





Place the cloth in alizarin (2) for several minutes. Then remove it and two colors appear (3). Mordants also keep dyes "fast" in textiles.

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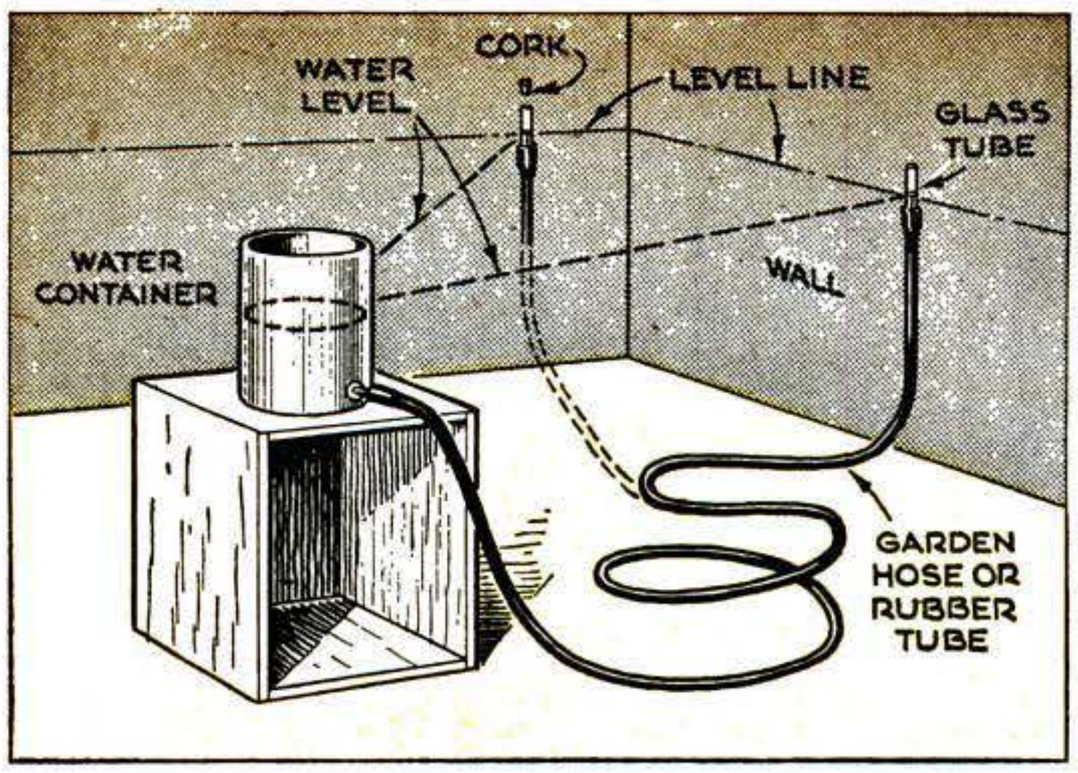


Water Device Finds Level Line

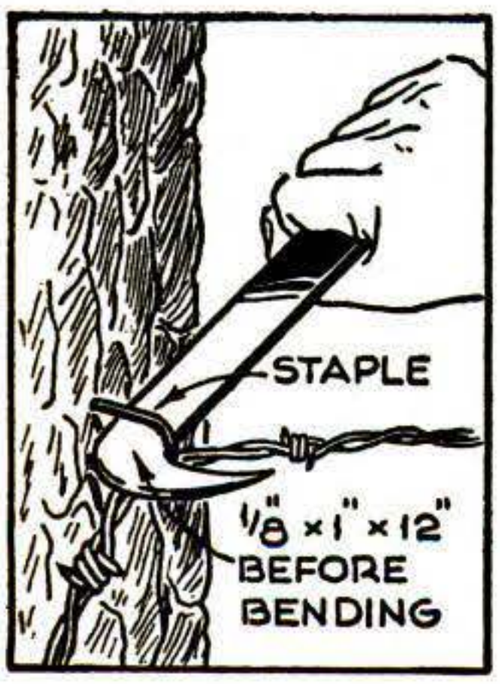
WAINSCOT and half-panel installations and other jobs sometimes require a level line regardless of floor or ceiling sag. One method that eliminates tedious use of a straightedge and carpenter's level utilizes the old principle that water seeks its own level.

A 1-gal. tin can with a bit of copper tubing soldered near the bottom is the water container. Attach a rubber hose with an open glass tube in the other end. Partly fill the can and set it at the desired height; then mark the level at various points on the wall. A cork in the glass will help prevent spilling, but remove it each time before marking the wall.—JOHN S. HUDSON.

Shear Pins Stored in Motor

EXTRA shear pins for an outboard motor will always be at hand in an emergency if they are wrapped in a rag and kept in the hollow steering handle. Remove the rubber grip to insert them and replace it or, if there is no grip, use a cork or wood stopper to keep them in.—R. A. J.

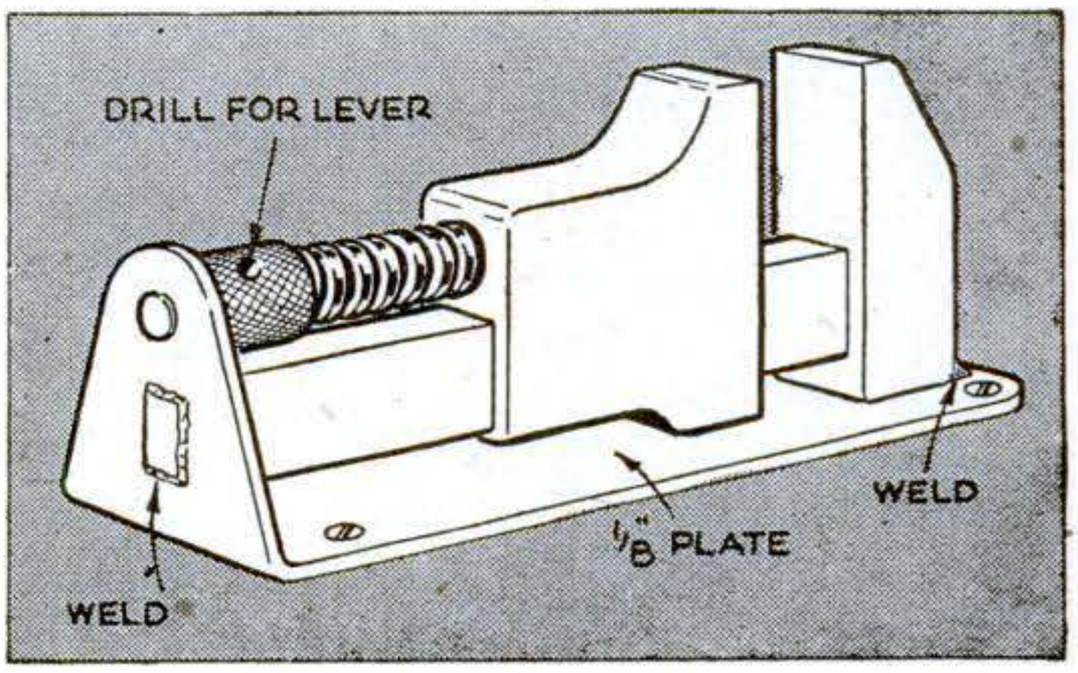
Pulling Out Stubborn Staples



BENT at an angle and ground to a point, a length of scrap strap iron will give you a tool for pulling staples that defy other methods of removal. The point is driven under the staple, which can then be pried out with ease.—I. H. W.

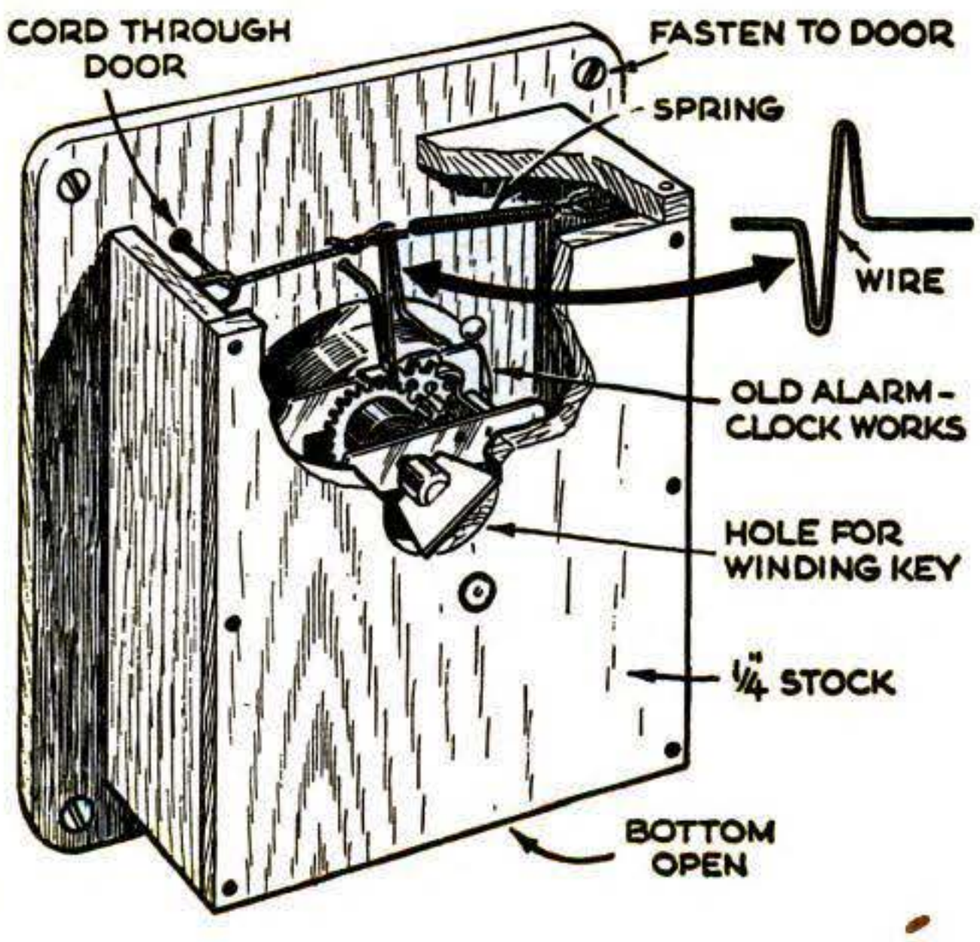
Vise Made from Monkey Wrench

ITS handle discarded, a monkey wrench can be welded to a bent steel plate to make a small bench vise. Bolted or screwed to the bench, the vise is useful for holding small jobs for filing and other operations. It is also handy in hard-soldering and brazing, saving the regular vise from exposure to intense heat. Weld the fixed jaw and the end of the shank to the plate, as shown below. A removable lever in the screw aids tightening.—ROLLA J. SMITH.



Alarm Clock Rings as Doorbell

AN OLD alarm clock can be substituted for a doorbell if its alarm spring is still good. Encase the works in a wood box, as shown below, and mount the box on the inside of the door with a string and wire attached so a pull on the string will release and ring the alarm. A spring also attached to the wire shuts off the alarm when the string is free, and a bead on the end of the string keeps it from slipping back through its hole in the door.—GUTHRIE B. STONE.



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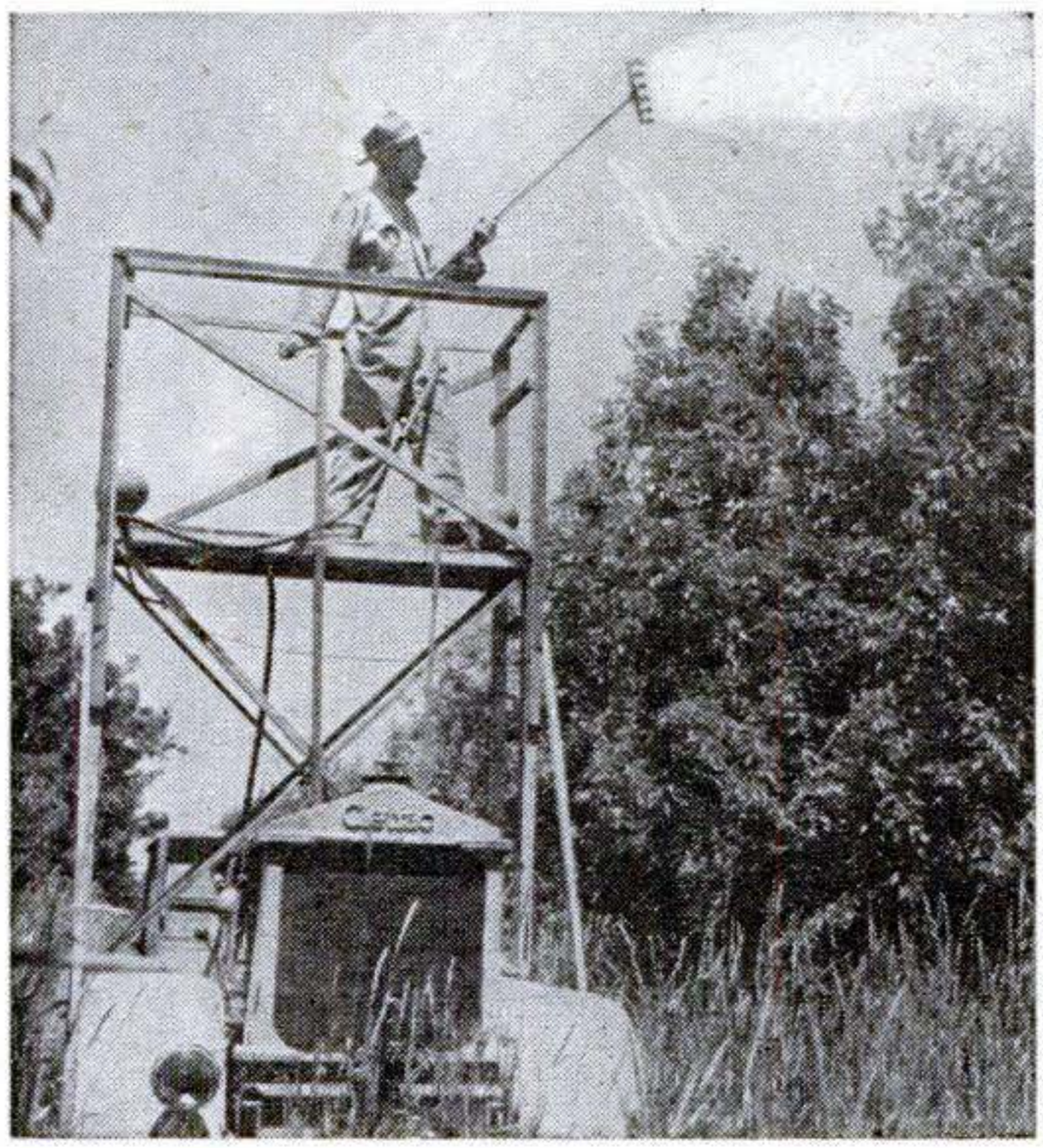
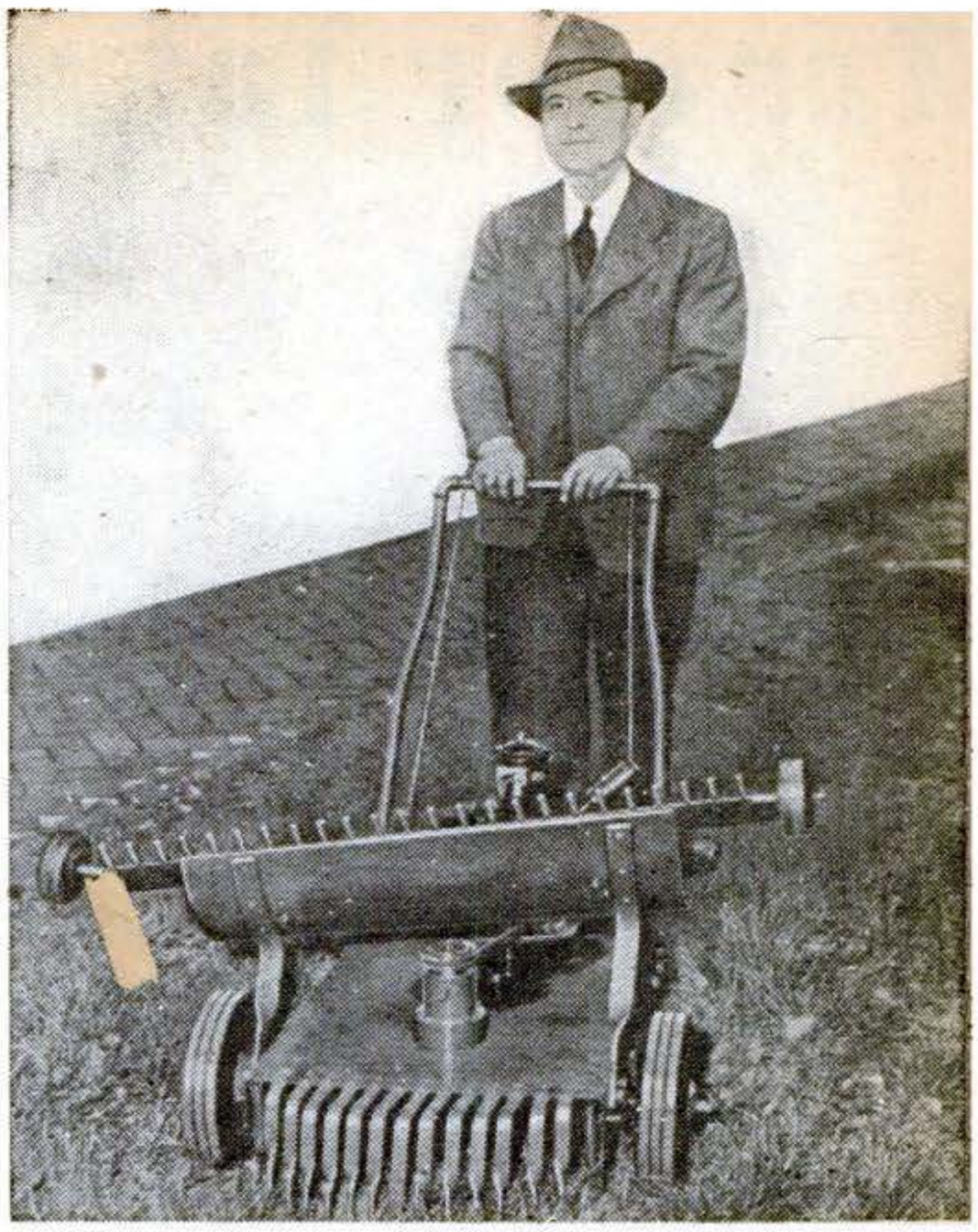
Tractor Drive on Spray Tower

VERTICAL extensions on the steering wheel, clutch, and throttle of his tractor enable Jack Fletcher, of Littlerock, Calif., to drive the machine himself while he is spraying pear trees from above. Usually spraying from a tower built over the spray rig carried by a tractor is the work of two men—one driving and one spraying. Since pear trees are sprayed six or seven times a year, Fletcher estimates a considerable saving in man-hours and money.



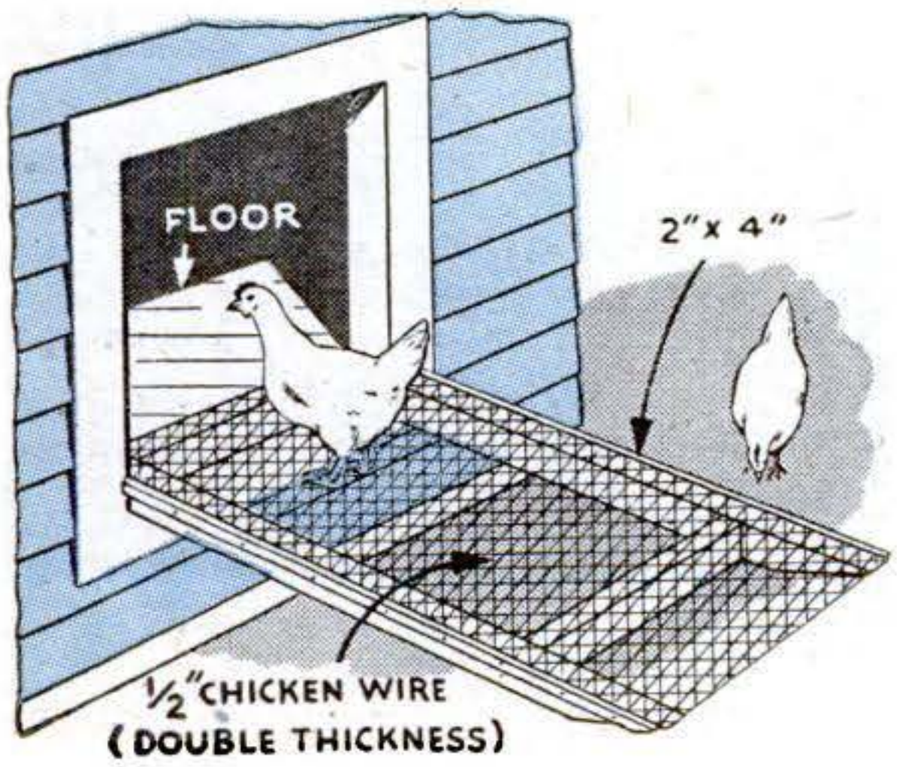


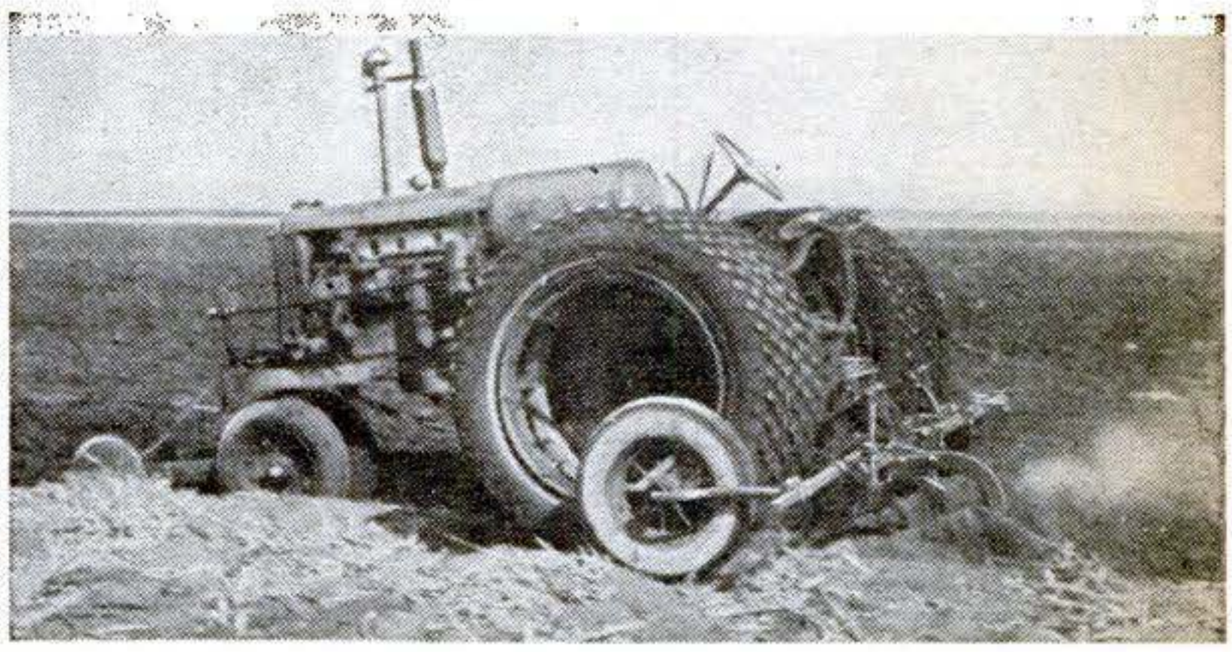
Lawn Mower Does Several Jobs

MOWING and raking the lawn are both accomplished by the motorized machine shown above being piloted by its builder, James Badlat, of Des Moines, Iowa. In winter, when grass is no longer growing, a snowplow (shown in raised position) can be lowered to clear up to 5″ of snow. A brush under the hood simultaneously sweeps the snow.

Door Mat for Henhouse

A MAT of doubled ½″ wire mesh on a frame of two-by-fours keeps the henhouse clean for E. Lucille Thompson, of Burnaby, B. C. The chickens wipe their feet automatically before entering the door.





Driverless Tractor Plows in Circle

EQUIPPED with an automatic guide, the self-driving tractor shown above will plow 25 acres in 24 hours. Instead of a central tether, the guide is a tandem arrangement employing an old tractor-wheel guide and a disk coupled to the bar 3′ ahead of the tractor wheels. The guide follows the furrow previously made. If it jumps out, power is cut off. F. O. Masten, of Sudan, Texas, developed the guide.

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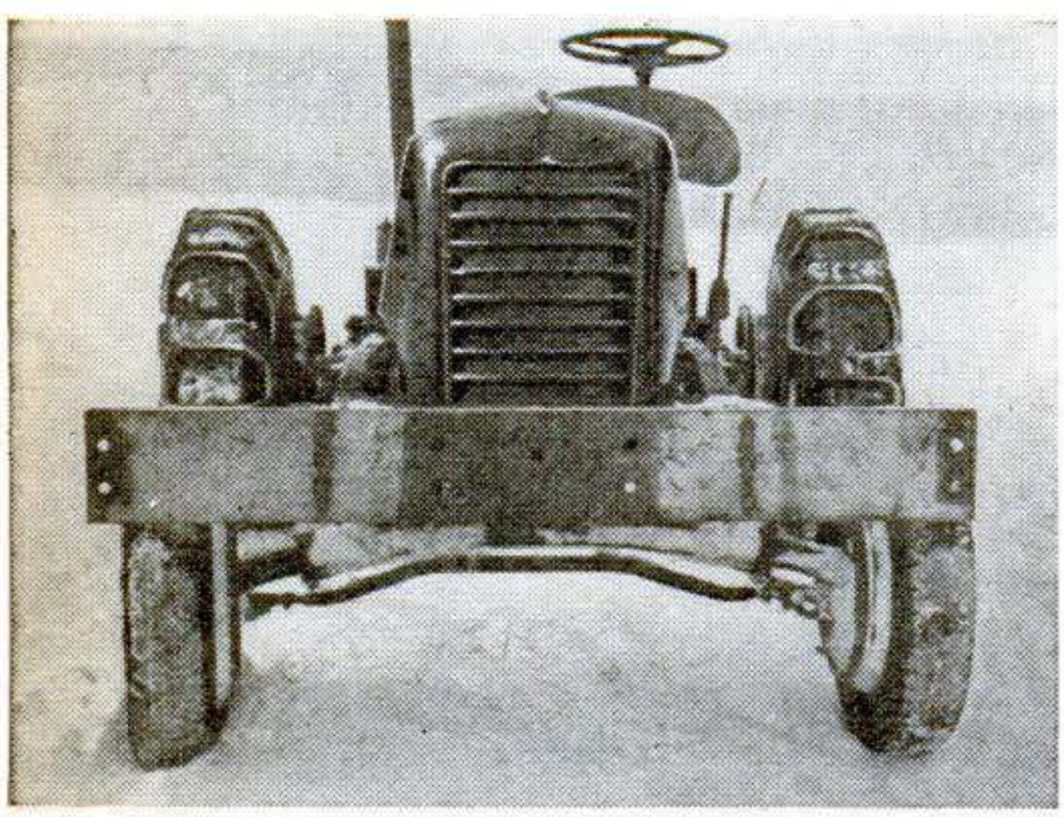
Tractor Takes to the Woods

Ruggedly built for work off the beaten path, this tractor has an inverted front axle to give greater ground clearance and a high bumper to break down underbrush. A saw can be mounted on the bumper.

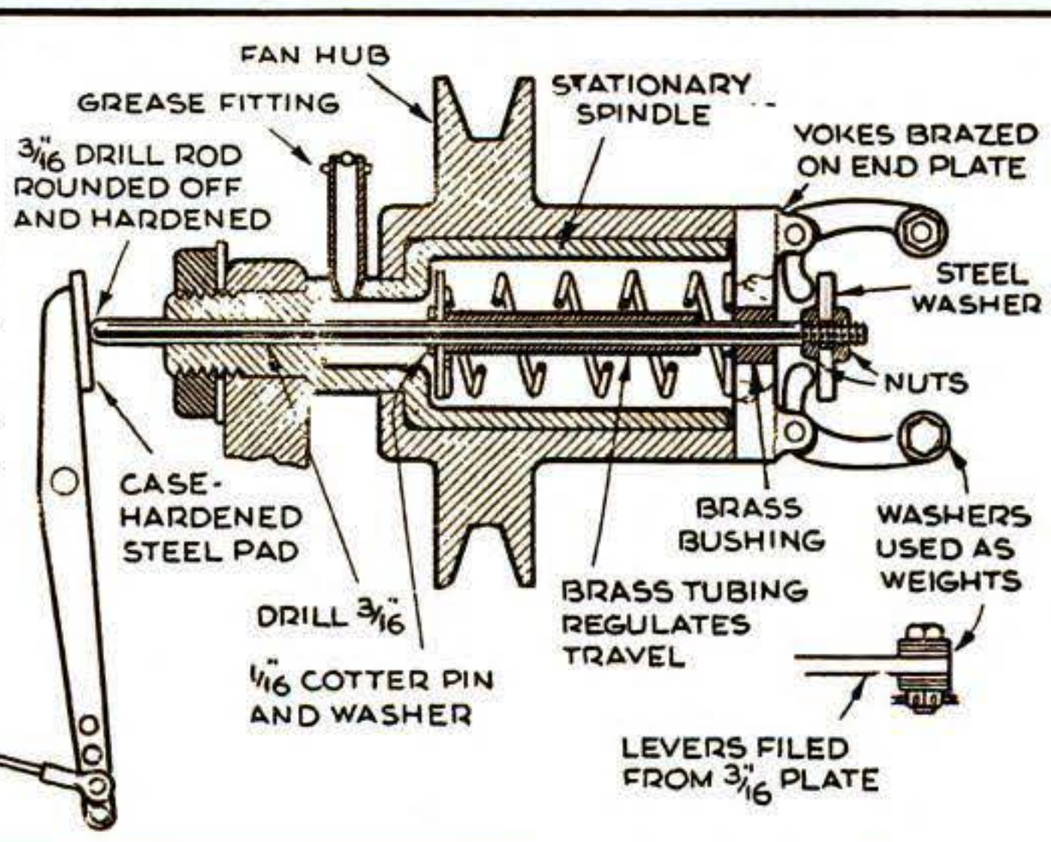


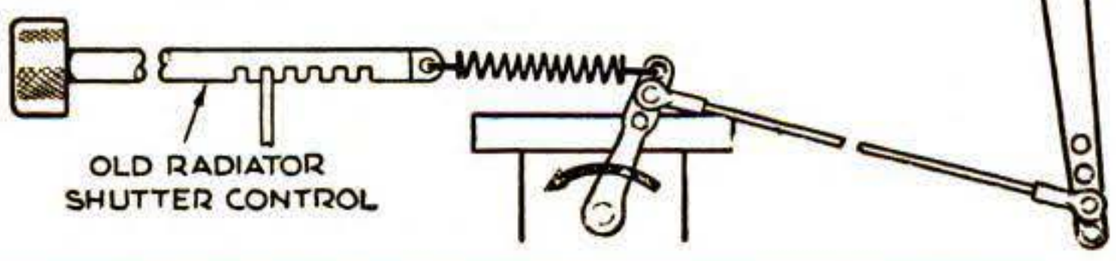
BECAUSE I frequently drag boats to Canadian fishing lakes far off the highway, this tractor has to get out of a lot of tough spots. I assembled it with such conditions in mind, and it hasn't let me down.

A truck frame and rear axle were used. After all except the four top leaves had been removed from the springs, the axle housing was drawn up solidly against the frame with U-bolts. This provides a permanent and accurate axle alignment and the springs take up part of the wheel thrust. The front axle, also from a truck, was inverted to increase ground clearance and was pivoted on a frame cross member so the tractor could operate on uneven ground.

With an independent brake for each rear

A GOVERNOR for this tractor was made from an Essex fan hub and spindle. The latter was drilled for a 3/16″ push rod, and a spring was mounted in the hollow body to counteract the centrifugal weights. Adjustments are made by shifting the spring tension with the shutter control, by varying the weights, or by pivoting the levers in different holes.





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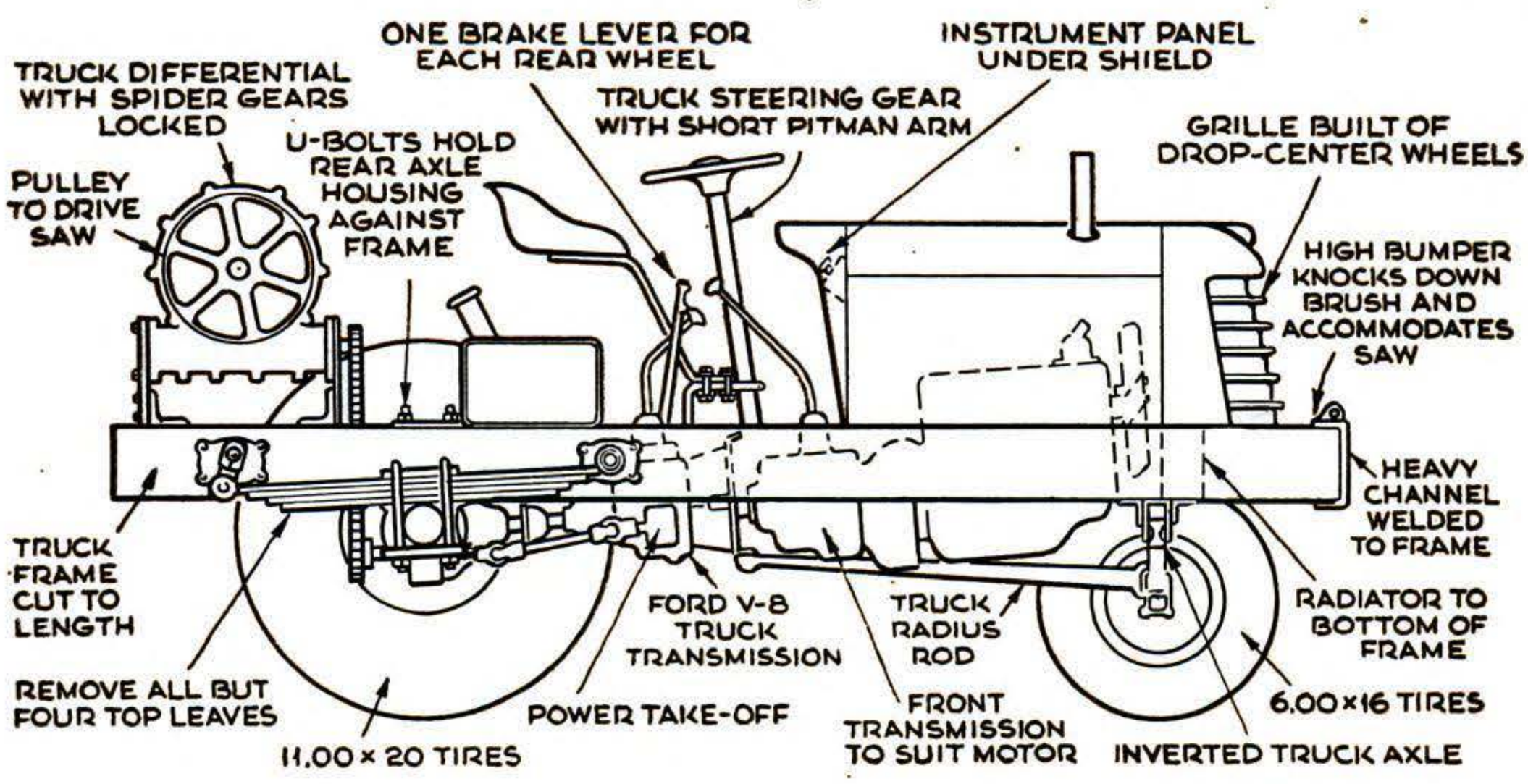
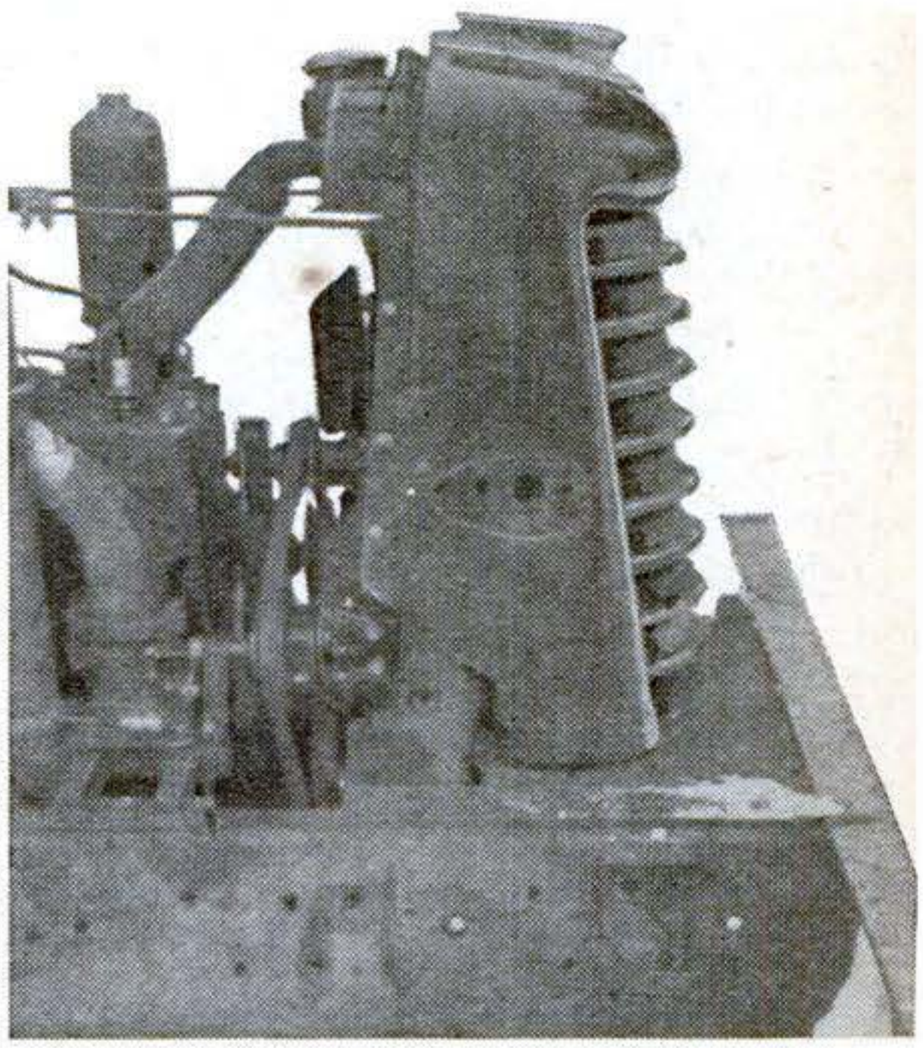
DESIGNED FOR ROUGHING IT, THIS HOMEMADE MACHINE USES TWO TRANSMISSIONS TO BUCK NORTH-COUNTRY SNOW AND MUD

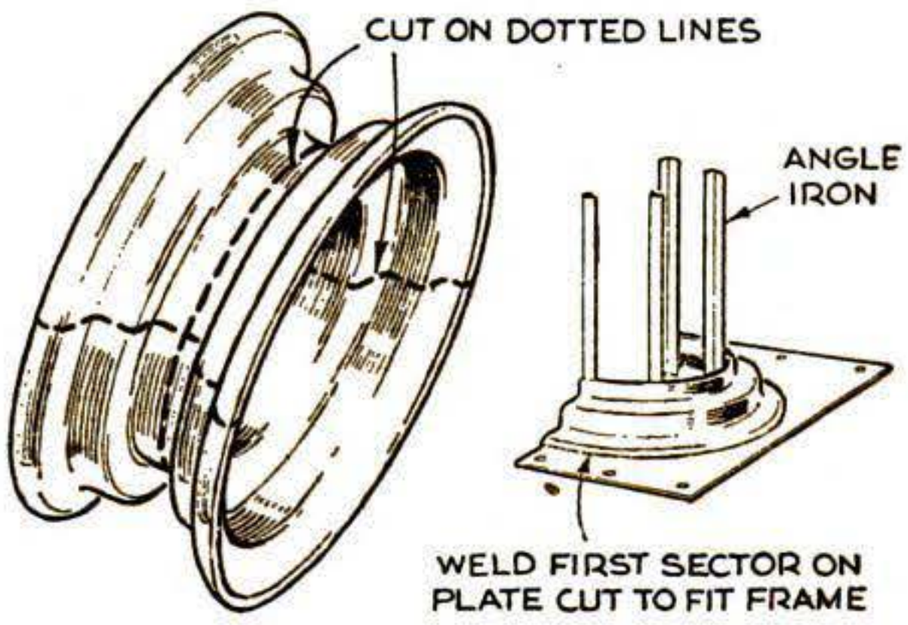


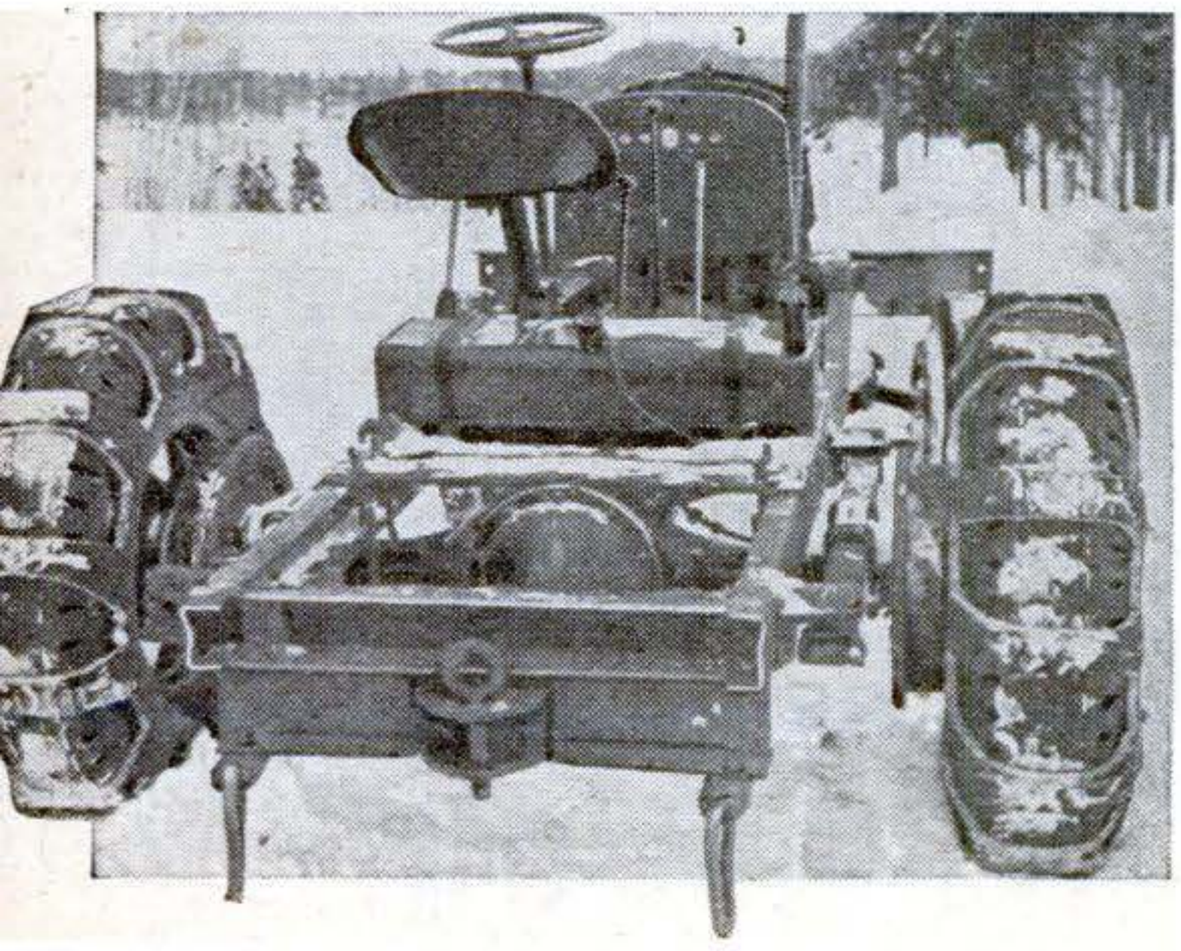
wheel, I can get out of many a hole just by holding the spinning wheel and forcing the other to work. Two transmissions, mounted in tandem, give a wide range of speed and power, the rear one operating a winch mounted at the back. A pulley on the winch can be used to drive a saw.

Both rear tires are fitted with ground-gripping "boots" made of larger tires. A mixture of snow and water placed in these casings and allowed to freeze kept them rigid for sawing. The bead was cut at four places on one side, and eight side plates from old car springs then were bolted to the four sections as shown in the photo at the top left. Turnbuckles attached to the plates tighten the "boots."—G. Burton Brown.



Guarding the radiator is a heavy grille built as shown from sectors of drop-center wheels.





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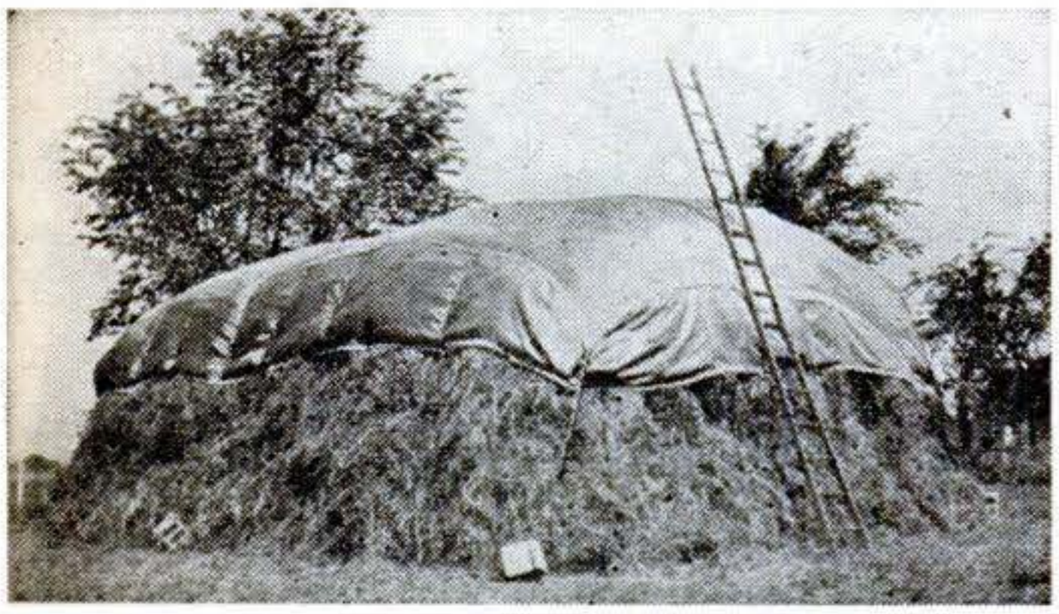
AIR BLOWERS CURE HAY QUICKLY

Gasoline-driven blower in housing at left forces air through hay to speed drying. Higher yield results.

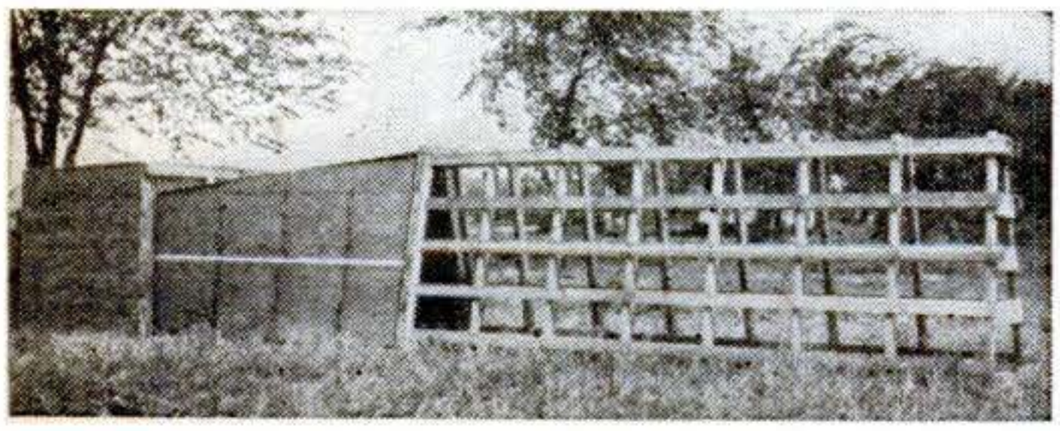
QUICK curing of hay with forced air promises to save the 25 percent of this crop that is sometimes lost with older drying methods, while yielding a product at least one grade higher. Progressive farmers using the new process find that not only is damage from rain or handling reduced, but also that quick-dried hay makes a top-quality feed. It requires the addition of little or no protein concentrate and results in more and richer milk with a greater vitamin content.

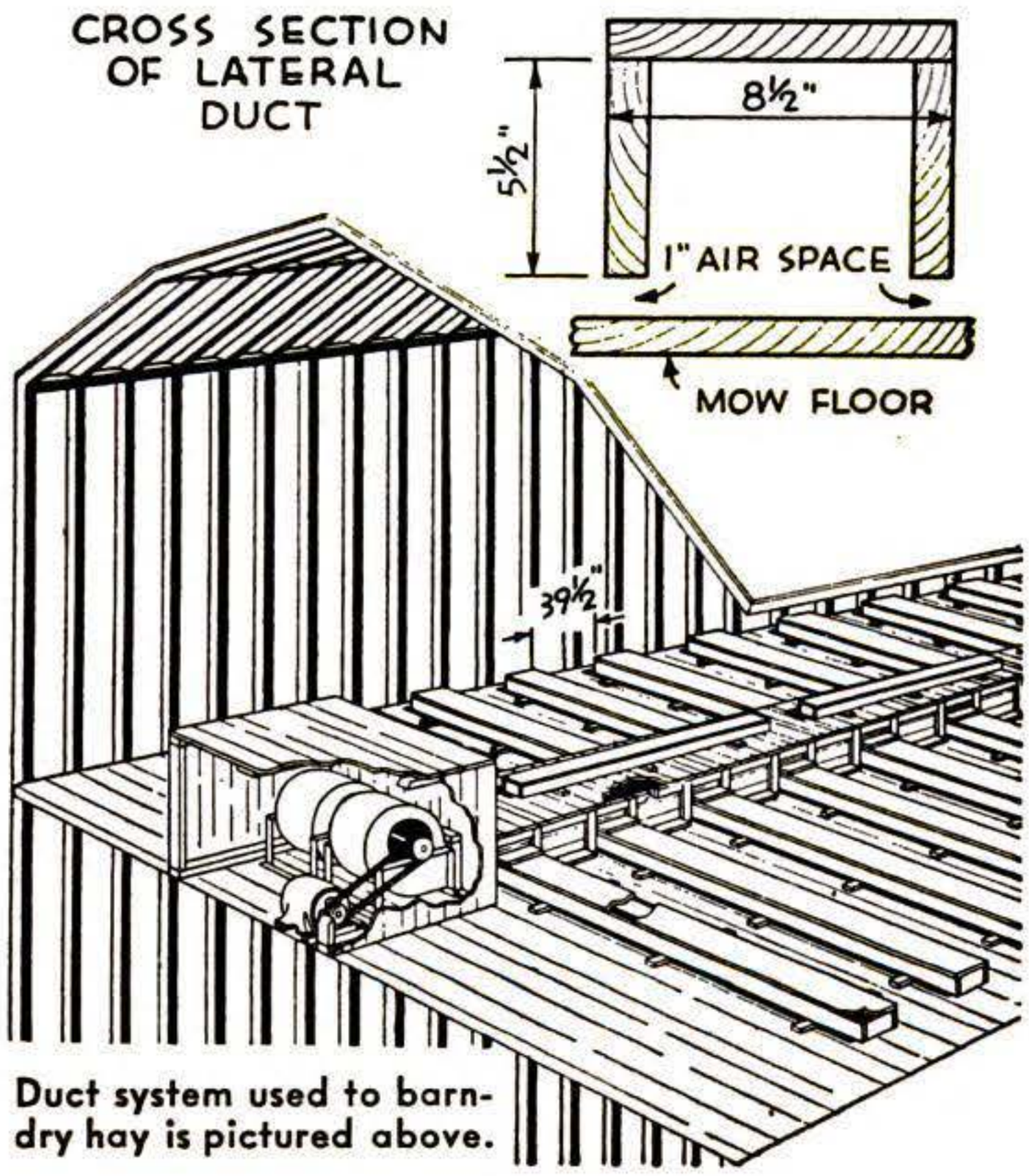
The systems devised by agricultural engineers at the University of Illinois and Virginia Polytechnic Institute consist simply of gasoline or electric blowers forcing air through ducts over which the hay is piled. Best results have been obtained with ducts set in a barn floor, but single ducts have been placed under exterior hayricks, which were covered with tarpaulins made of glass fibers. These tarpaulins shed rain, but permit moisture to escape from the hay.

In the usual barn-curing installation, the blower, located in the center of one end of the barn, forces air through a central main duct of sufficient size to carry at least 10 cubic feet of air per minute for each square foot of mow area at a velocity no higher than 25′ per second. Distribution of air through the hay is accomplished by smaller lateral ducts spaced 4′ or 5′ apart. Barn-drying will cure hay in one to three weeks.



A tarpaulin of glass fibers protects the hayrick above, which rests on open framework (below) for forced-air curing. Note the simple construction.





Duct system used to barn-dry hay is pictured above.

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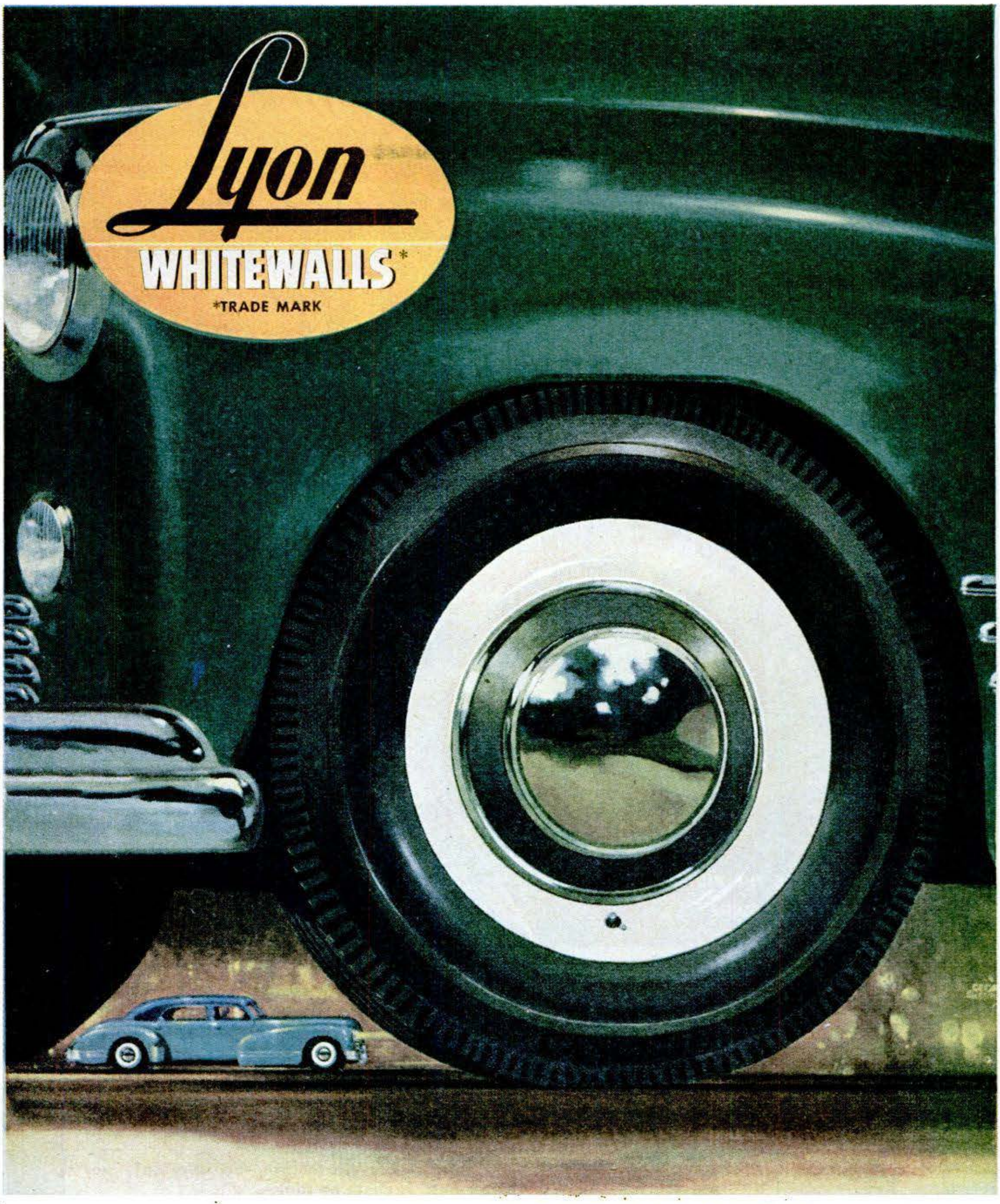

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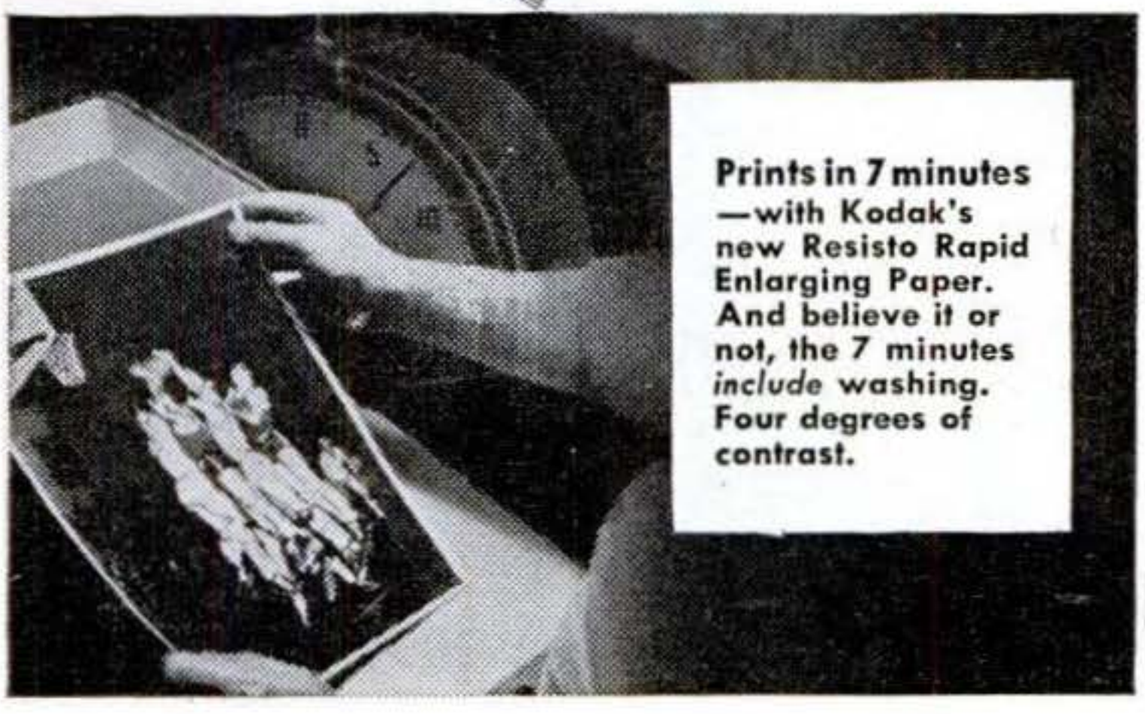

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▲ **FLEXIBLE CURVED TOOTH FILE** design — for use in special holder shown in picture at left.

●

RIGID CURVED TOOTH FILE with tang for accommodating conventional file handle. ▼

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The increased use of light-but-strong manufacturing materials—such as aluminum, magnesium, plastics and the softer alloys—means correspondingly greater demands for "shearing" type files.

These files reach their highest perfection in the newly designed Nicholson Super-Shear (exclusive with Nicholson) and the improved Nicholson Superior Curved Tooth. Both combine the qualities of *fast cutting* and *smooth finishing*.

Nicholson Superior Curved Tooth (top and middle) — Conventional design with extra-sharp milled teeth and long-lasting quality. Rigid type (with tang), and Flexible for use in special holder (see action view) on convex and concave surfaces. Also made in Narrow Flexible and Rigid Half Round Shell shapes.

Nicholson Super-Shear (*bottom*)—Its extremely sharp teeth are *milled* in an "off center" arc that varies the angles and spacing of the teeth to provide both fast cutting and smooth finishing when file is used with the overlapping right-toward-left stroke. Longitudinal serrations help break up chips.

SUPER-SHEAR FILE with wide-spaced short-angle teeth at right for fast cutting; narrow-spaced, long-angle teeth at left for smoothing. ▼

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Mower Eliminates Trimming

WITH a rotary action similar to that of two electric fans face downward, this 30-inch power lawn mower cuts and trims in one operation. Horizontal blades whirling at high speed reach to the edge of posts, fences and other obstructions, and at normal operating speed it cuts and trims about half an acre an hour. It is made by John A. Roebling's Sons Co., Trenton, N. J.

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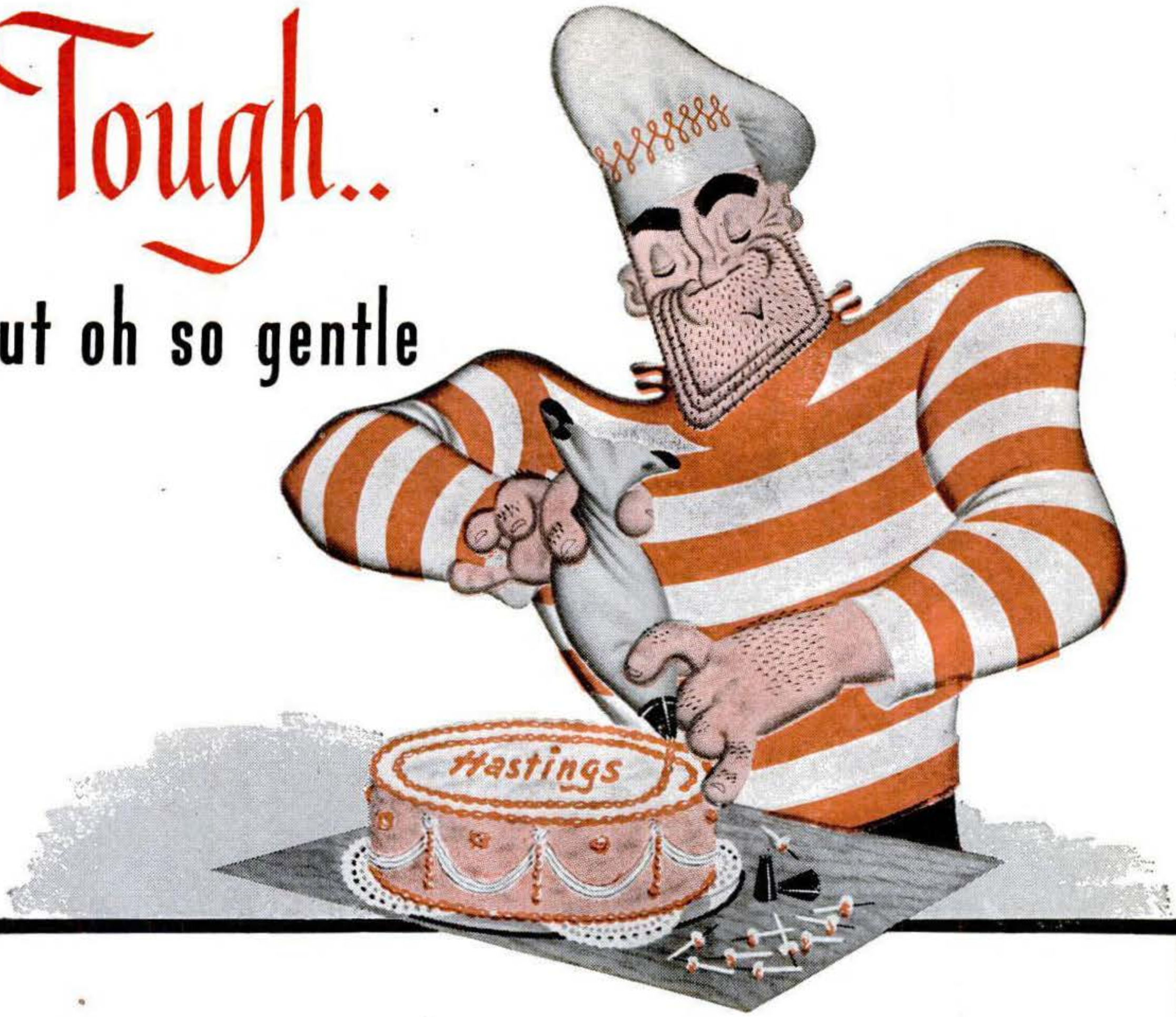
Tough..

but oh so gentle



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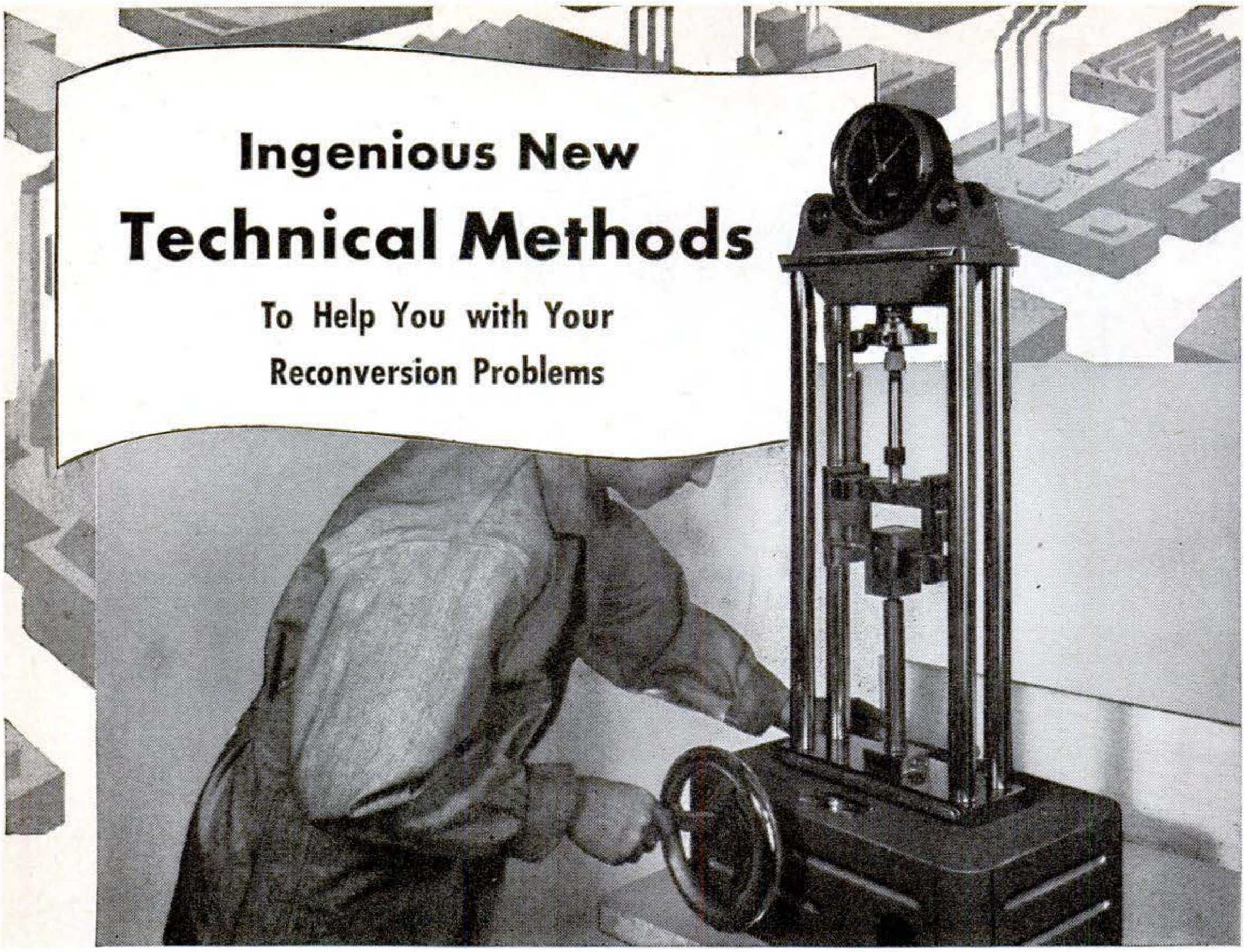

Portable Tester Checks Tensions Up To 10,000 lbs.—Right at the Workbench!

Standing only 37″ high, weighing but 137 lbs., the Dillon Universal Tester checks wire, copper, aluminum, fabrics, steel, etc. for tensile, transverse, compression and shear strengths. Available in 7 capacities, with interchangeable dynamometers, the Universal will test from 0 to 10,000 lbs. Special gripping jaws are made for every requirement.

The Universal Tester may be either hand or motor operated. No special training is needed to record accurate results instantly on the dynamometer. It is compact, simple, inexpensive—designed for small shops and plants everywhere.

Tests prove that workers, too, undergo strain and nervous tension on the job. That's why many factories urge workers to chew gum. Workers can chew Wrigley's Spearmint Gum right on the job—even when hands are busy. And the act of chewing helps relieve monotony—helps keep workers alert, thus aiding them to do a better job with greater ease and safety.

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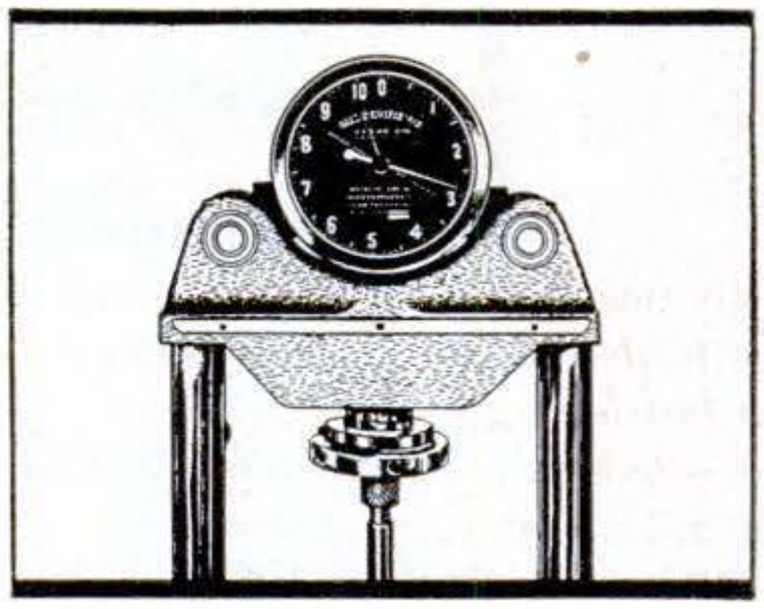

Interchangeable Dynamometer

AA-82

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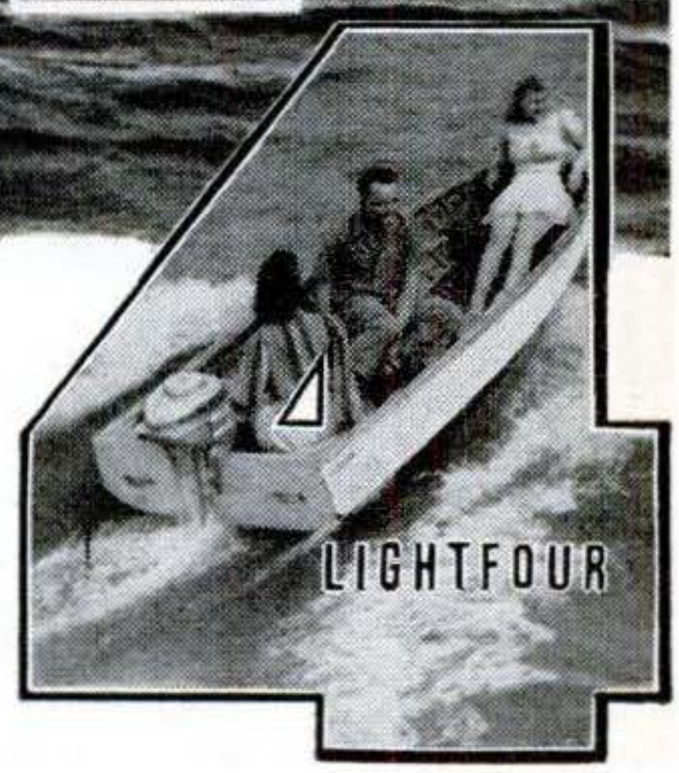

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5.4 to 50 horsepower*

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OUTBOARD MOTORS

* Zephyr, 5.4 h.p. at 4000 R.P.M.
Lightfour, 9.7 h.p. at 4000 R.P.M.
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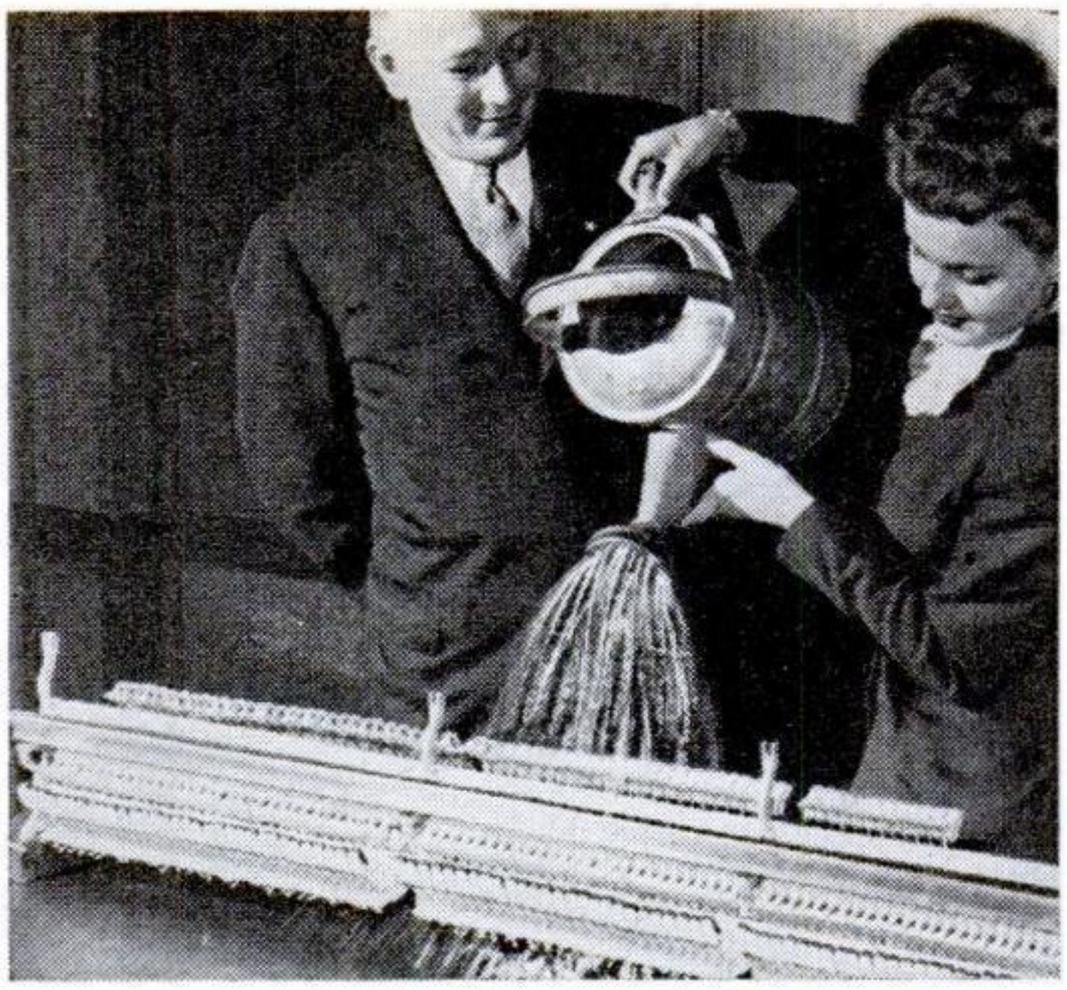

Moisture-Proof Piano Action

An action for spinet-type pianos that dampness does not affect has been made of plastics, magnesium, "manufactured leather," and special adhesives by Permat Products, Inc., of Rockford, Ill. Since the action has no wood parts, it is also termite-proof and therefore well suited for export to tropical countries.

New Mike Improves Pickup

The new Cardax crystal microphone, built by Electro-Voice, Inc., of South Bend, Ind., nearly doubles sound pickup in front, reduces background noise. It allows users more freedom of movement, permits increased loudspeaker volume.

Model Builders Attention!

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Hex	1/2"	3/8"	5/16"
Thread	3/8"-24	1/4"-32	1/4"-32
Thread Length	7/32	7/32	5/32
Weight, Grams	8	3 1/2	2 1/2

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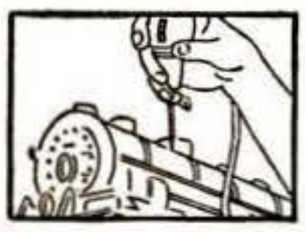
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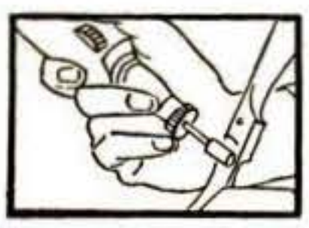
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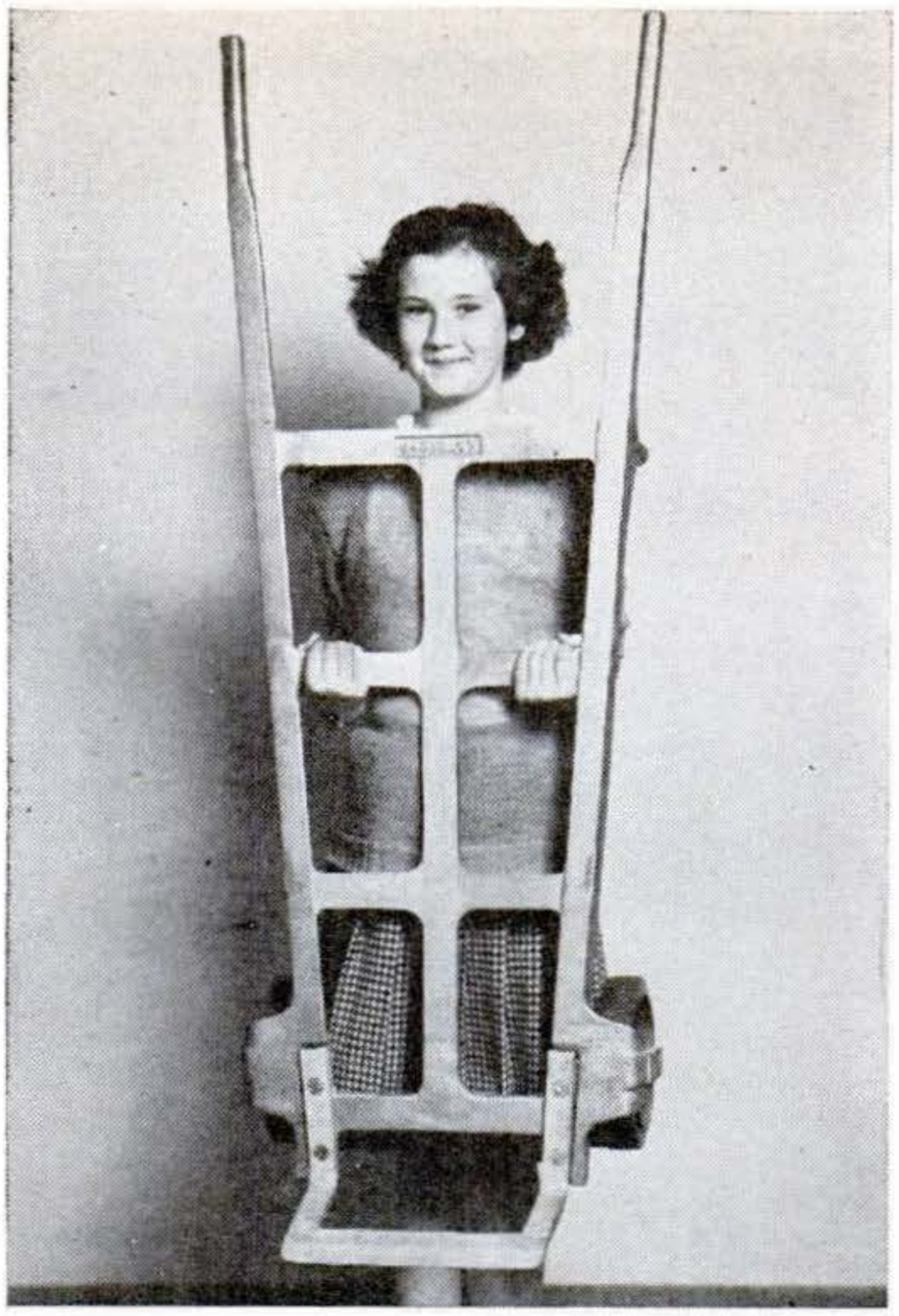
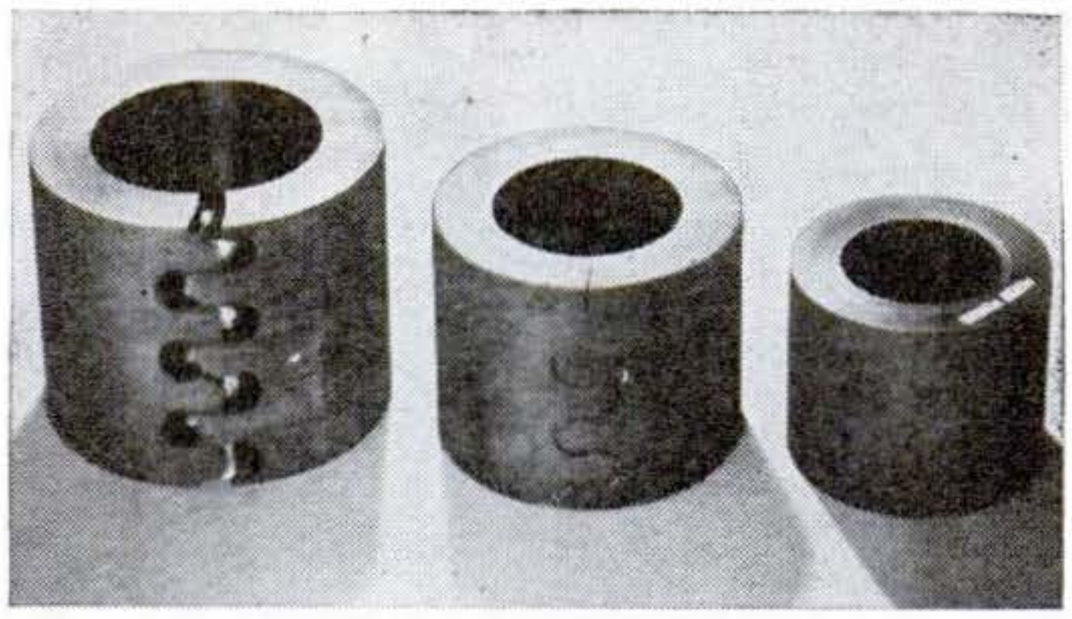


Featherweight Hand Truck

EVEN a child can lift this regular-duty hand truck of cast magnesium alloy, made by Magnelux Mfg. Co., of Los Angeles. It weighs just over 26 pounds, has doubly reinforced stress points, and there are no sharp edges in its improved design.



Reduces Pump-Packing Time

PACKING for pumps can be installed or removed in a few minutes when a new Super-lock "gland" packing, maufactured by Supreme Oil Tool, Inc., of Lynwood, Calif., is used. It is made of synthetic rubber specially compounded to resist oil, heat, and wear, and designed to give a perfect seal. There are sizes for all makes and models of pumps.

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So, see your Texaco Man today, and say: "*Marfak*, please."

With ordinary grease . . . you're taking the road shocks again after a few hundred miles.

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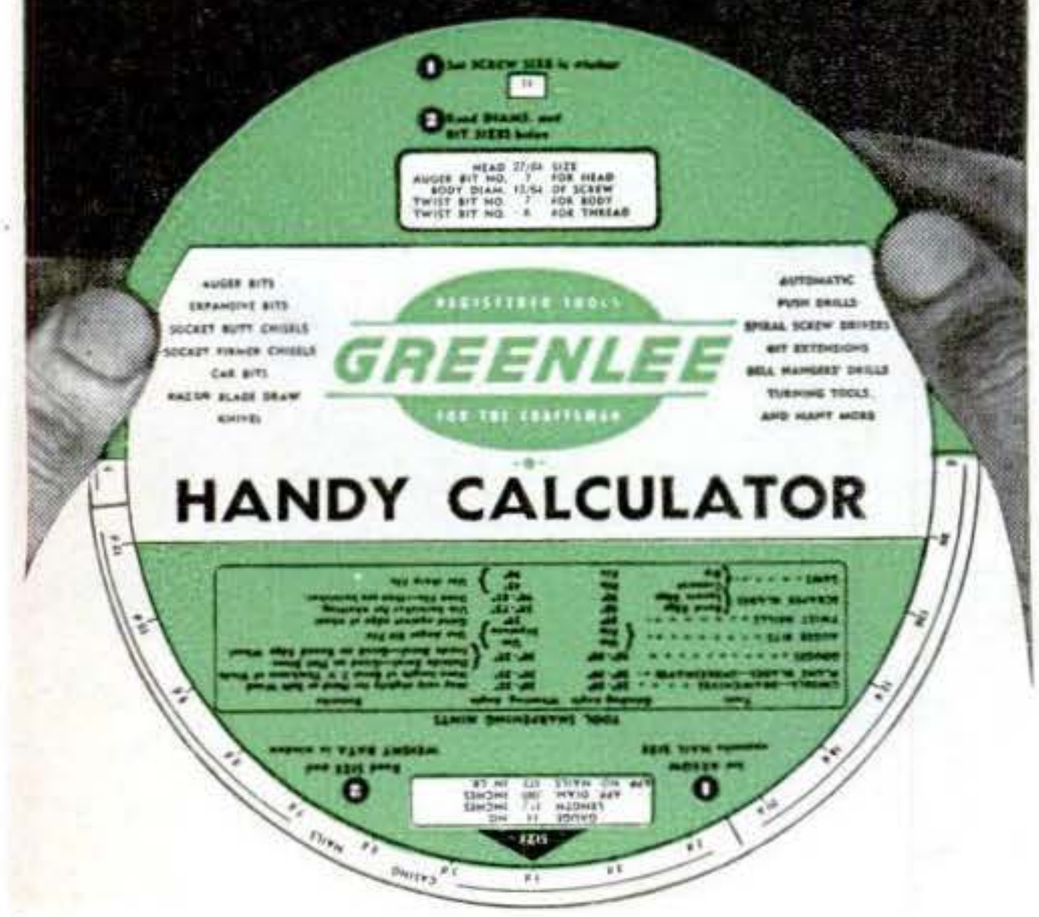

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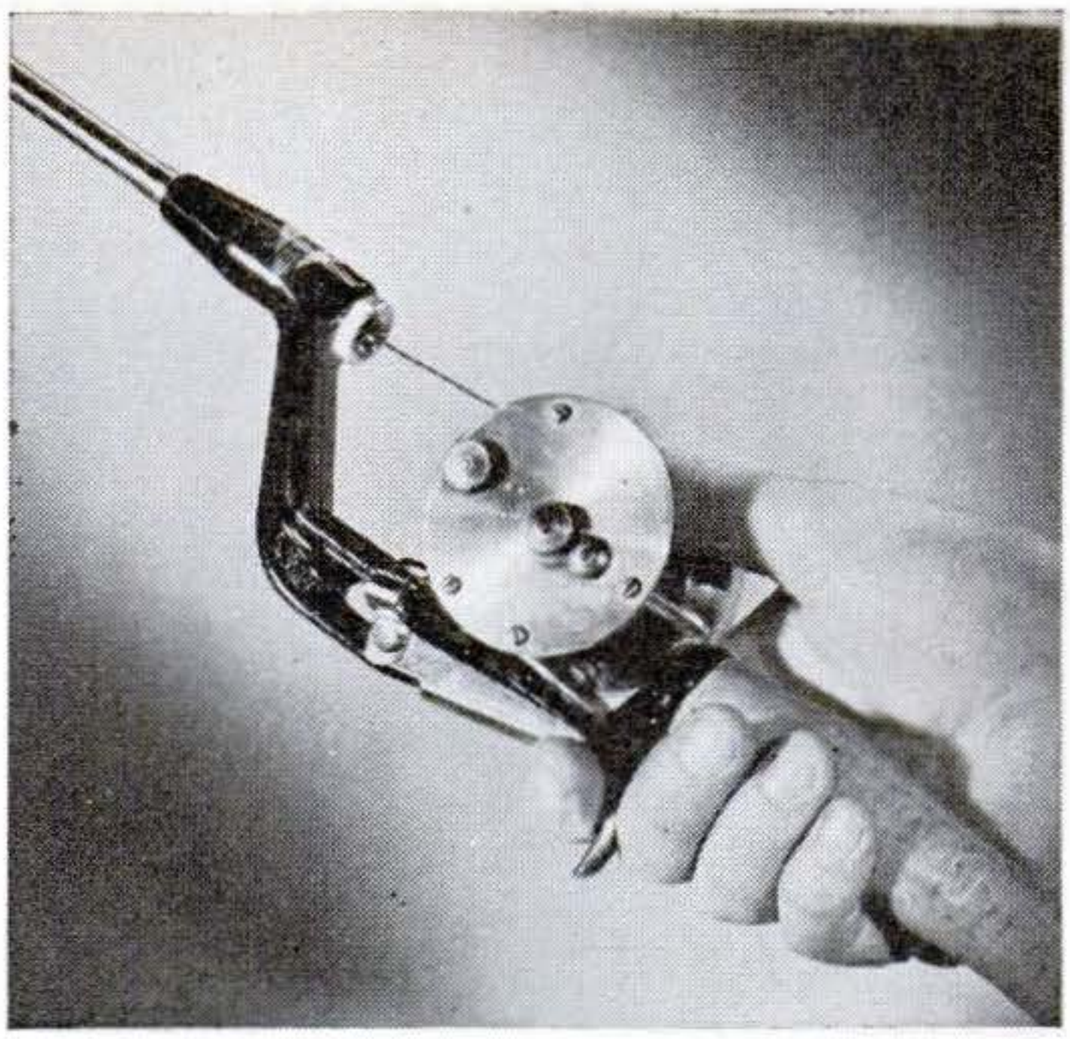

Casting Rod Has Inside Line

A TUBULAR casting rod known as the Guide-Free is made of beryllium copper, the wartime "nonfatigue" metal. An offset at the handle accommodates the reel, which is quickly fastened by a trigger-action cam lock, eliminating need for screwdriver.

Wheeling the Family Outboard

INSTEAD of lugging an outboard motor, you can now wheel it on the Moto-Roll, a 14-pound tubular steel vehicle with two rubber-tired wheels and a folding handle. Carrying it in an upright position prevents water from getting into the cylinders.

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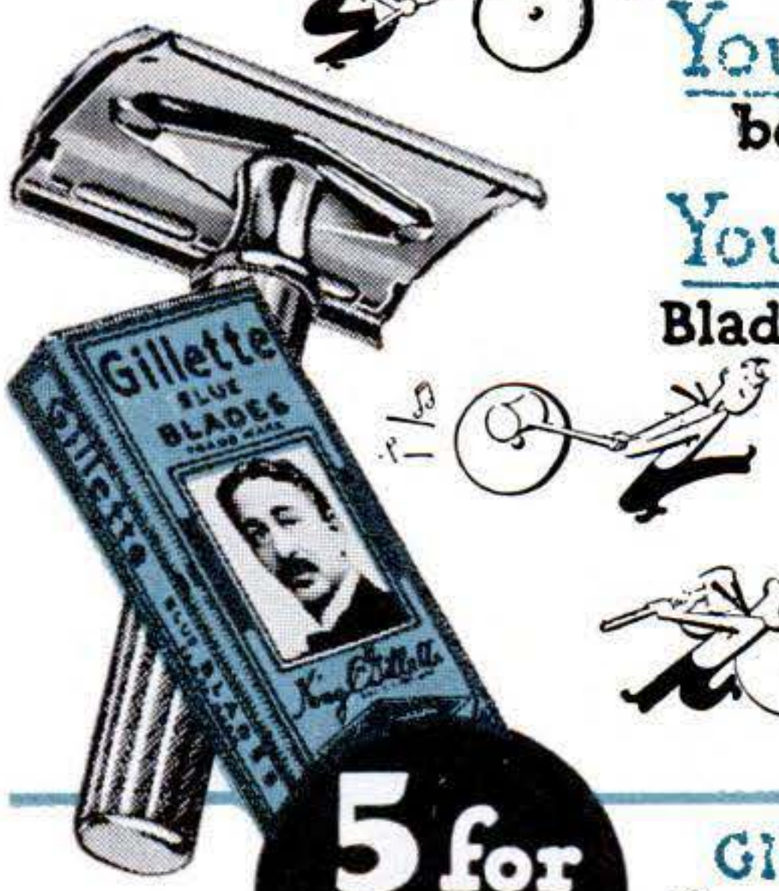

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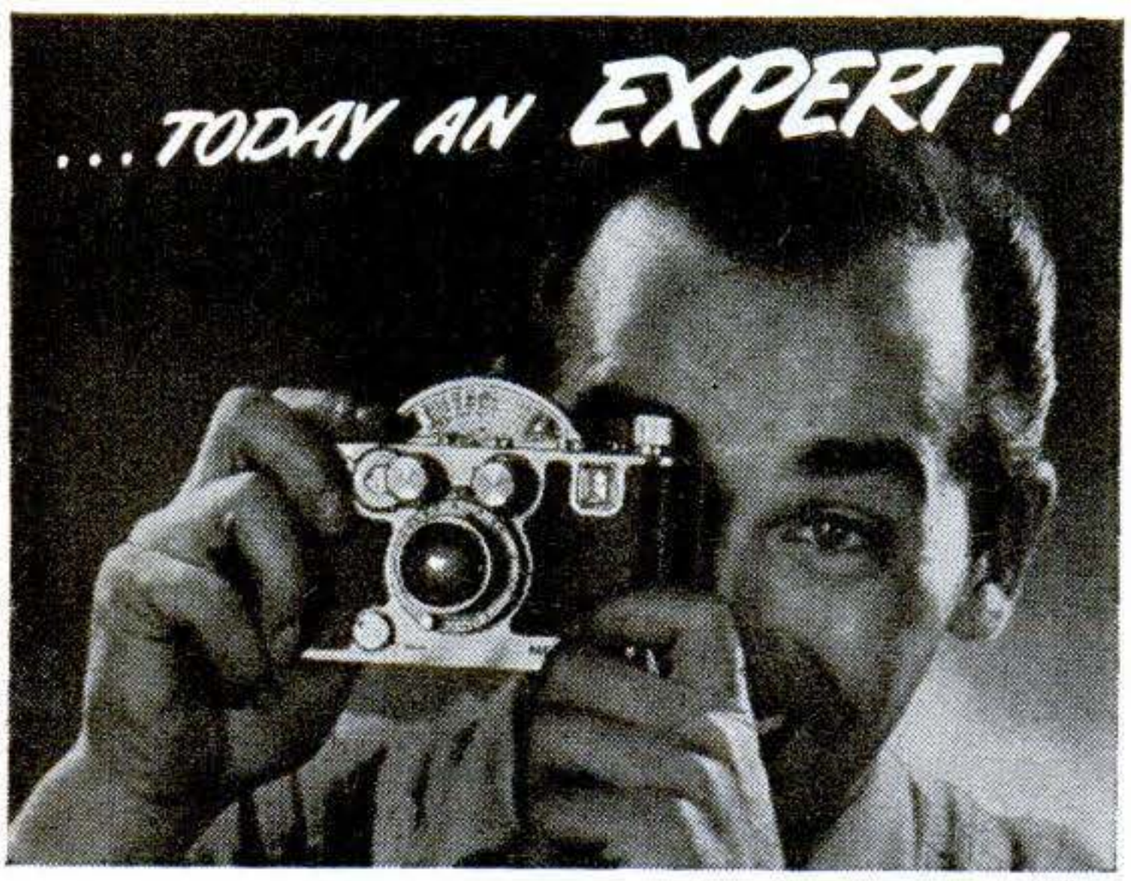

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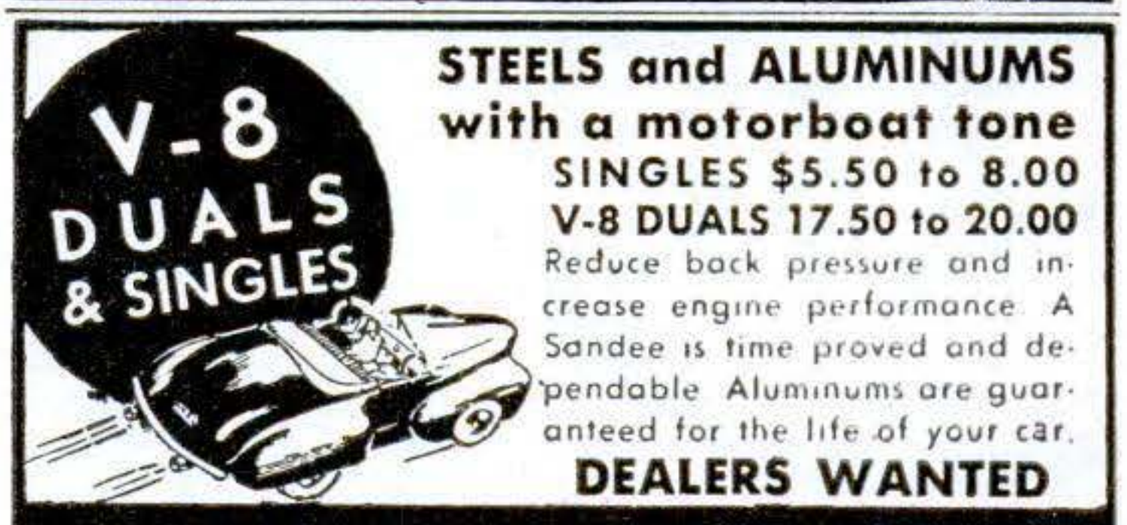

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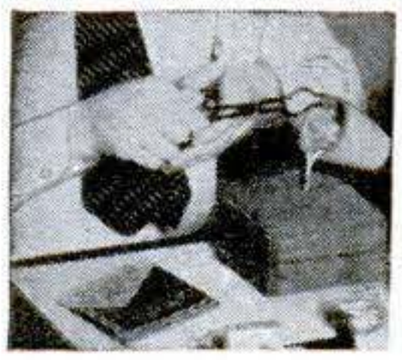

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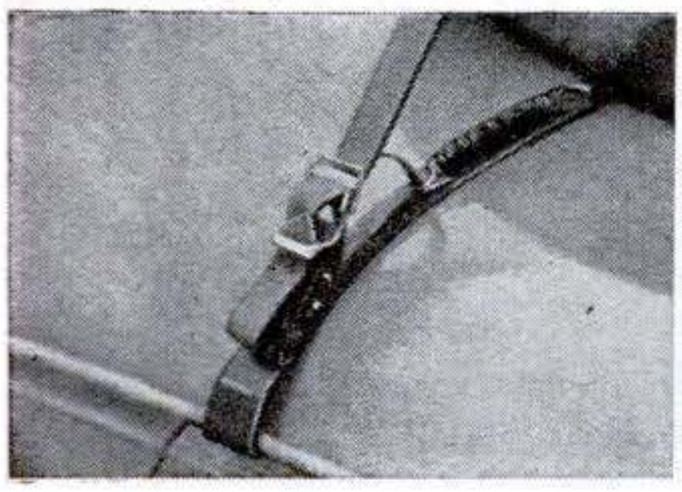

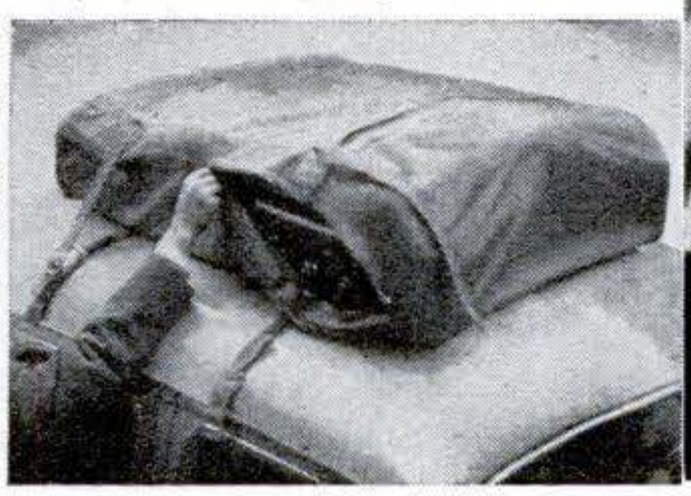

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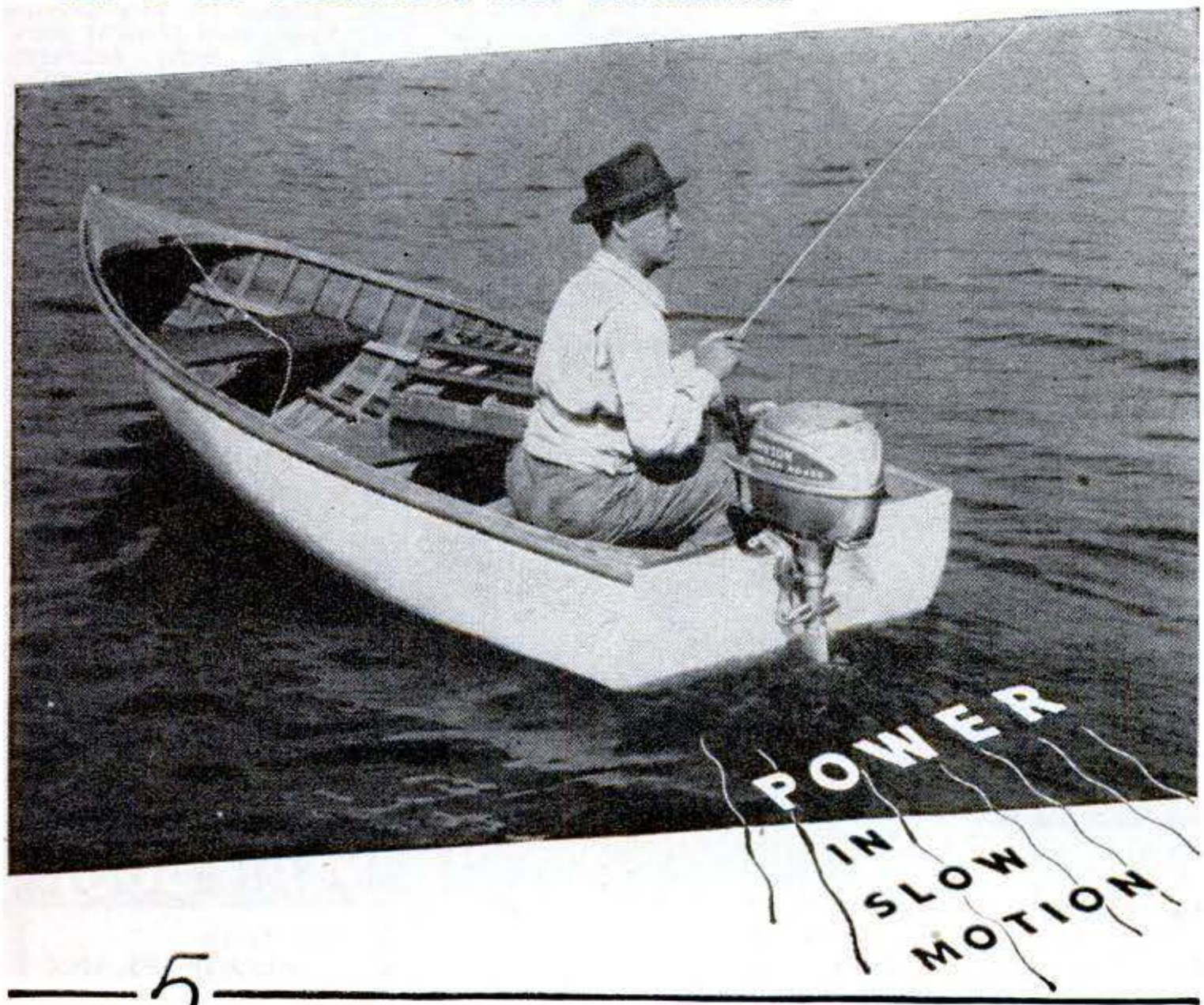

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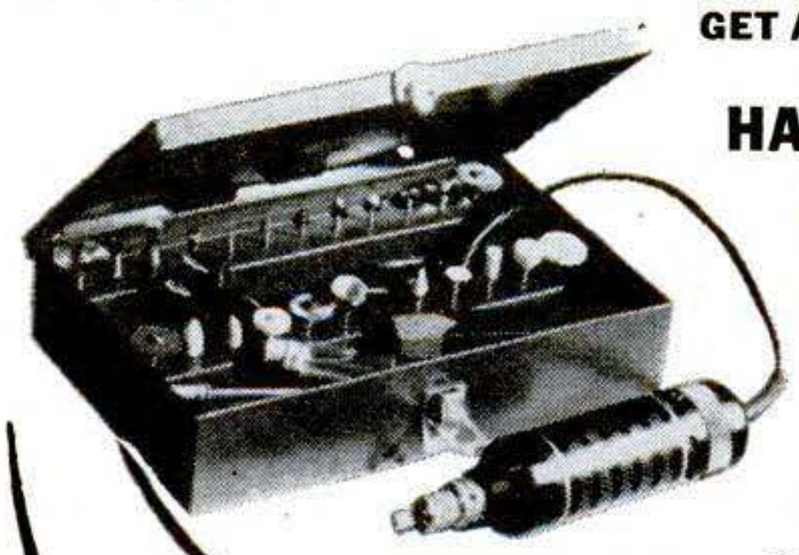

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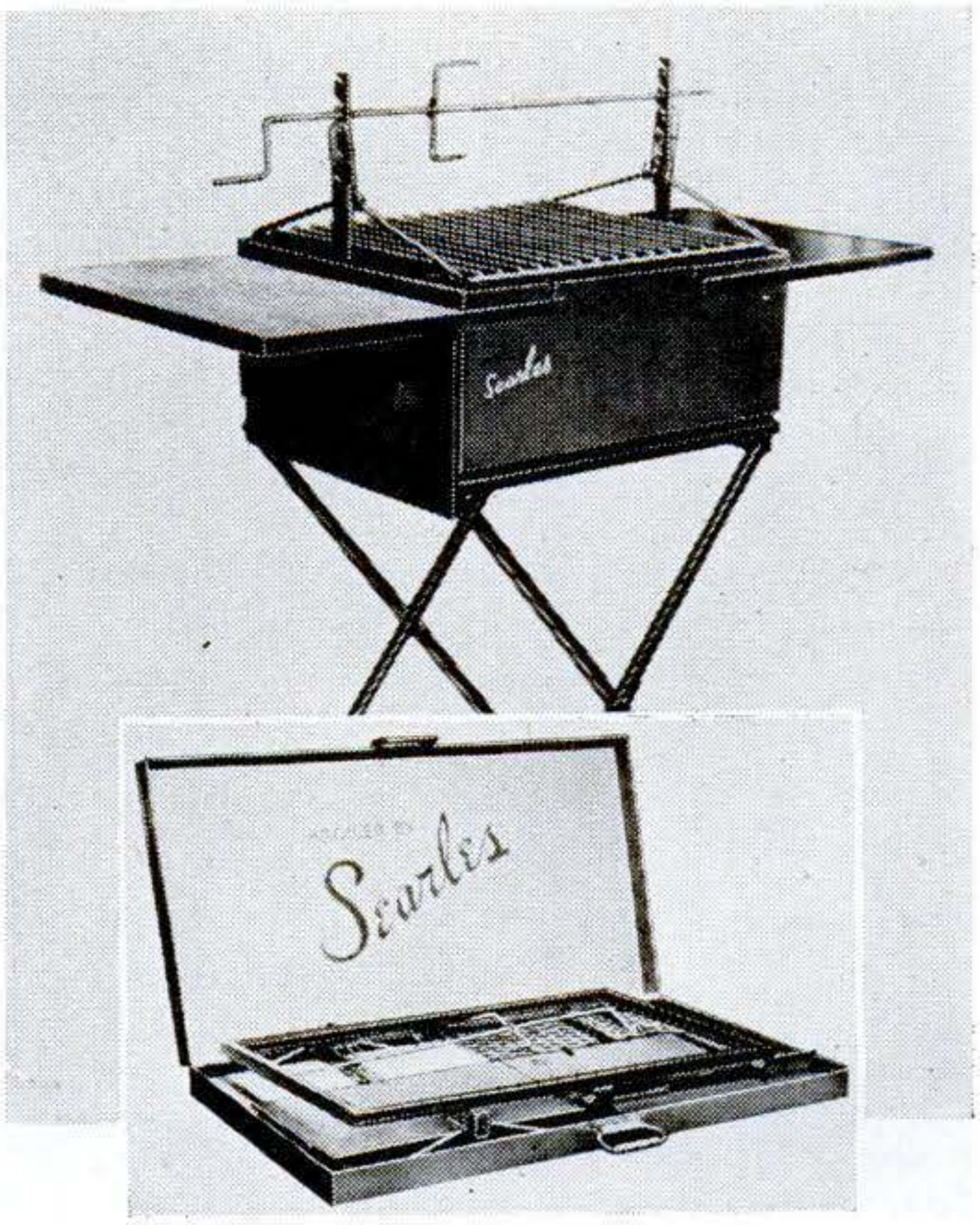

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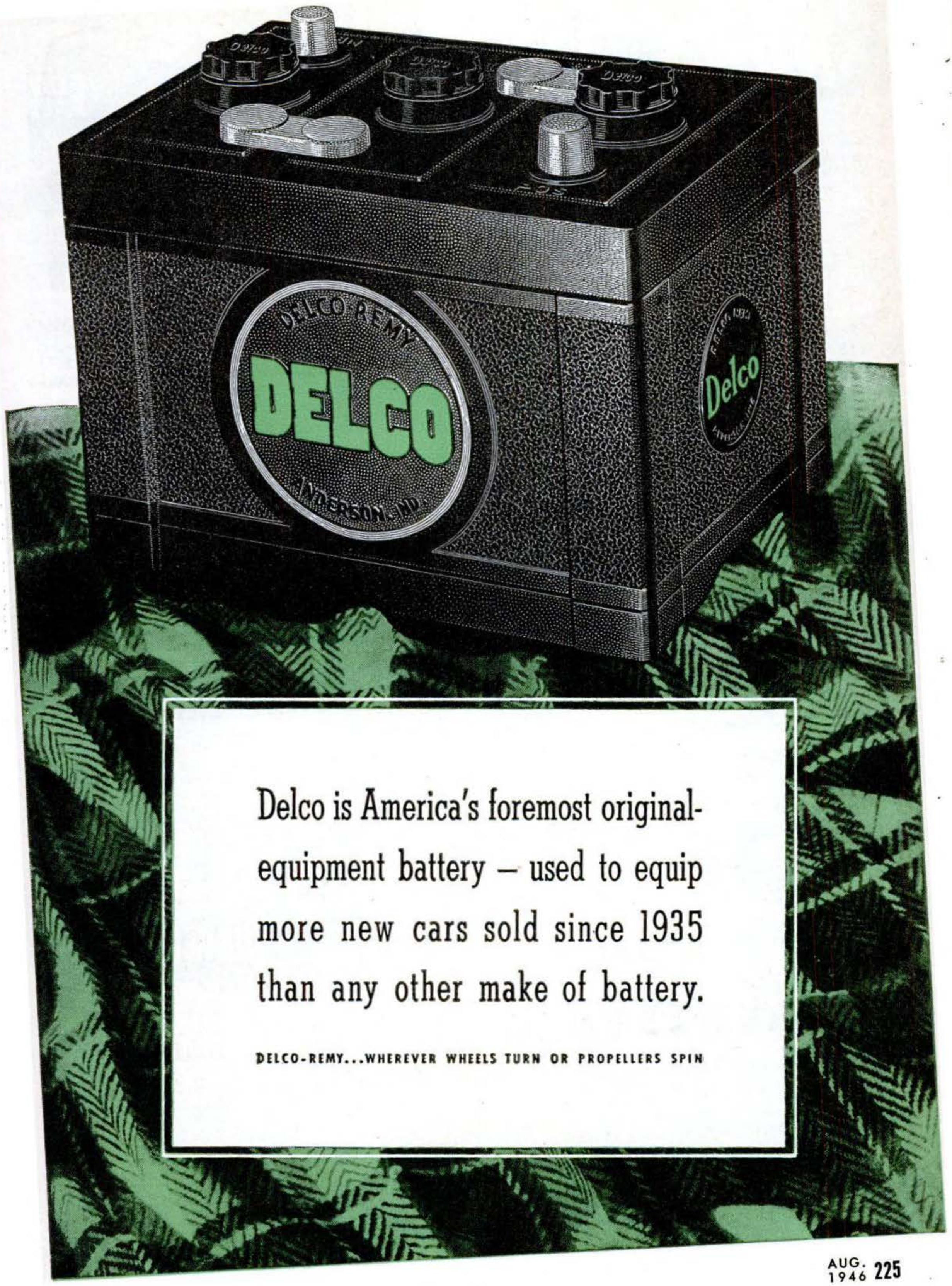

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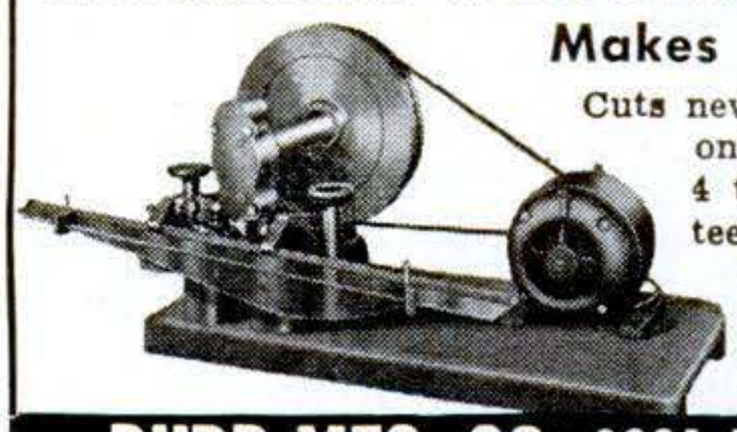

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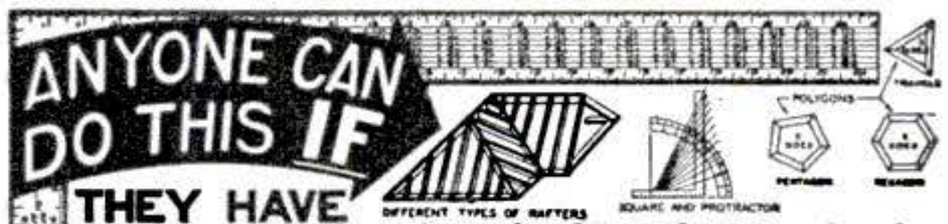

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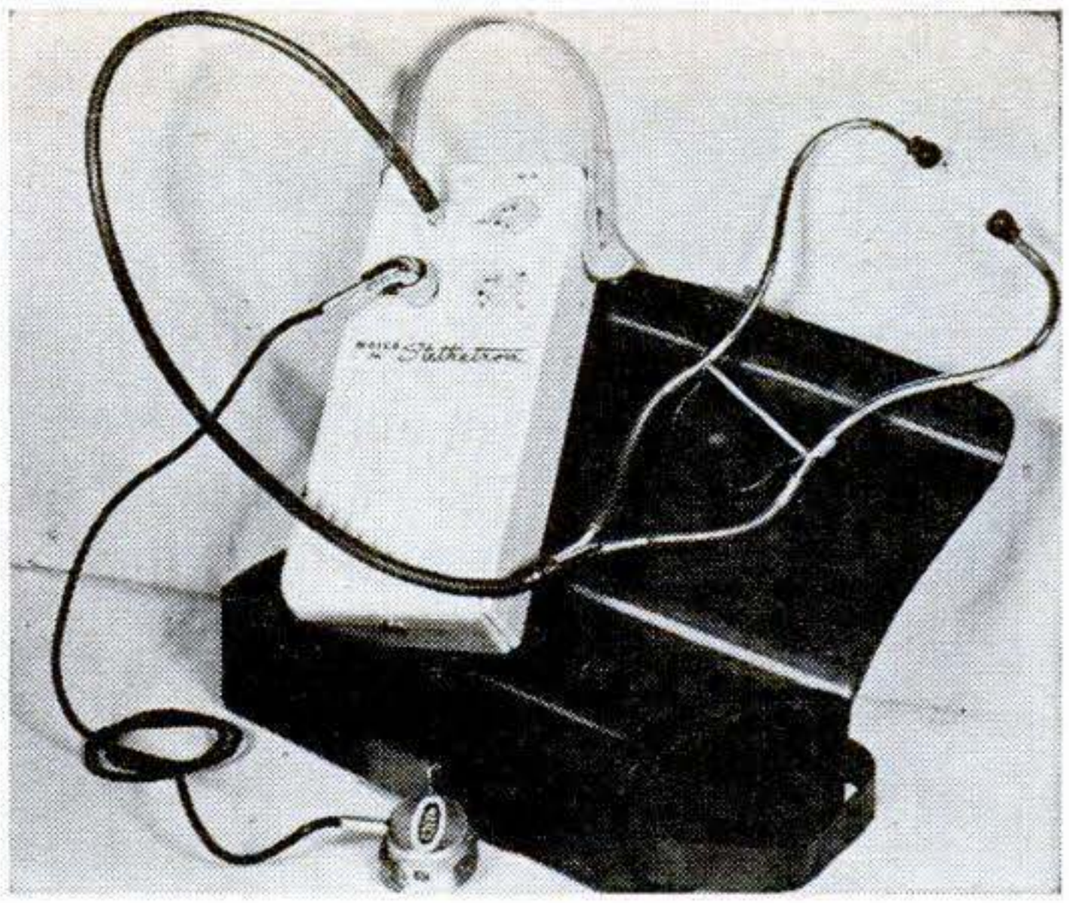

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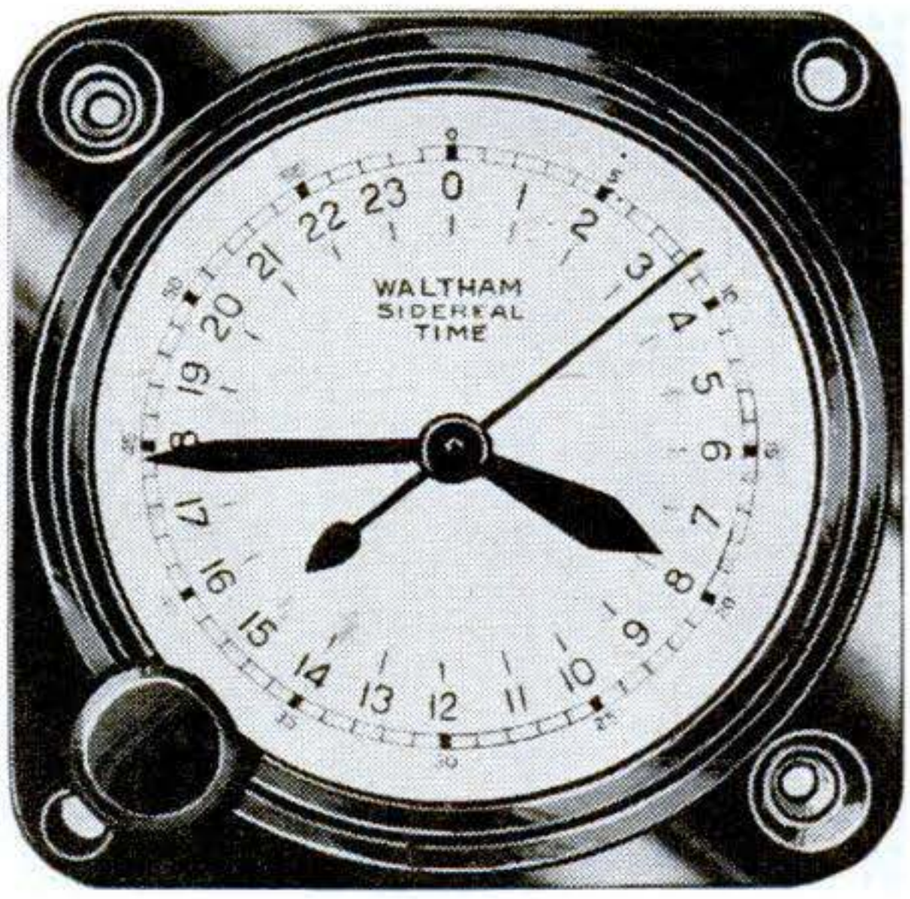

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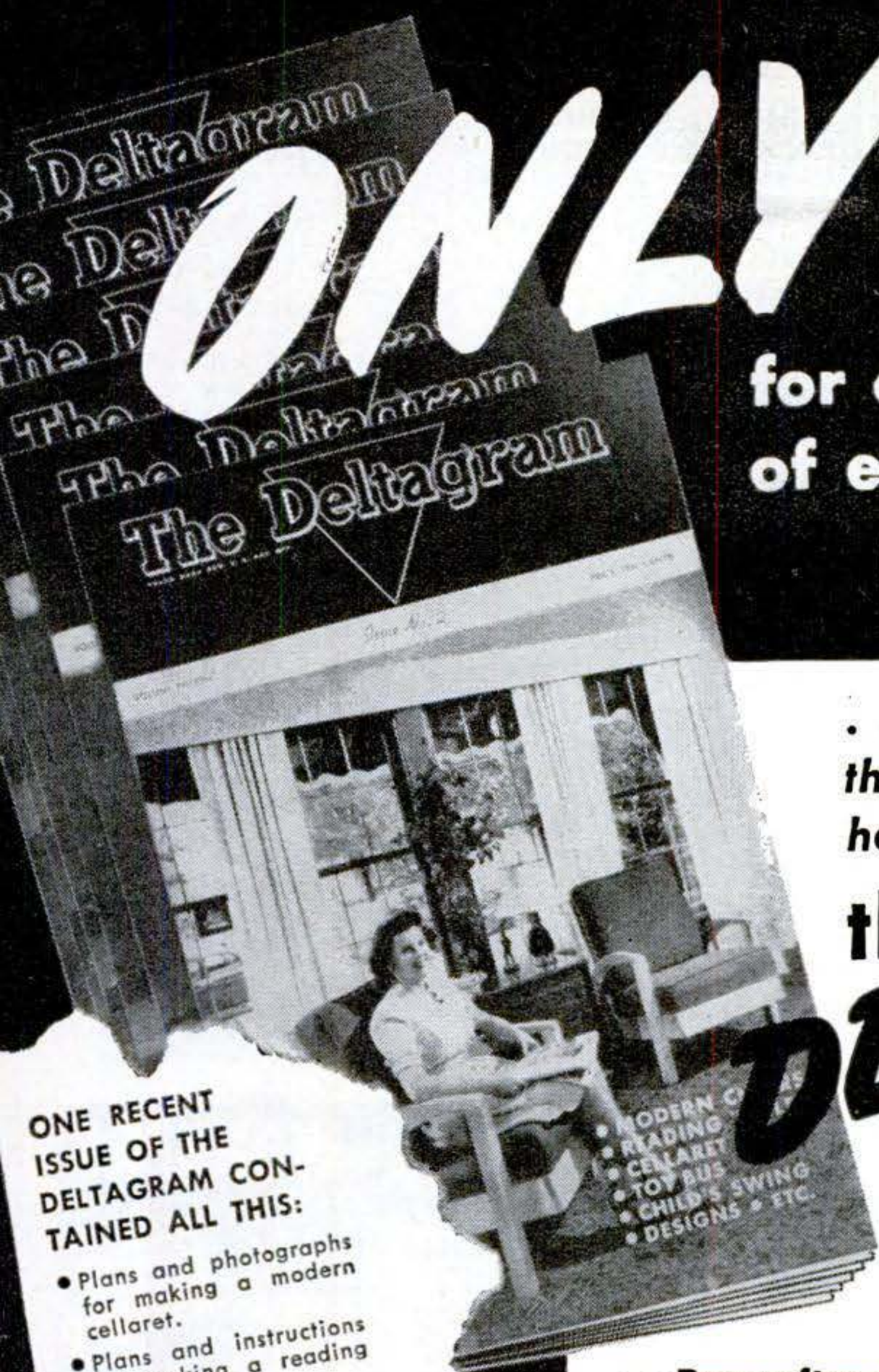

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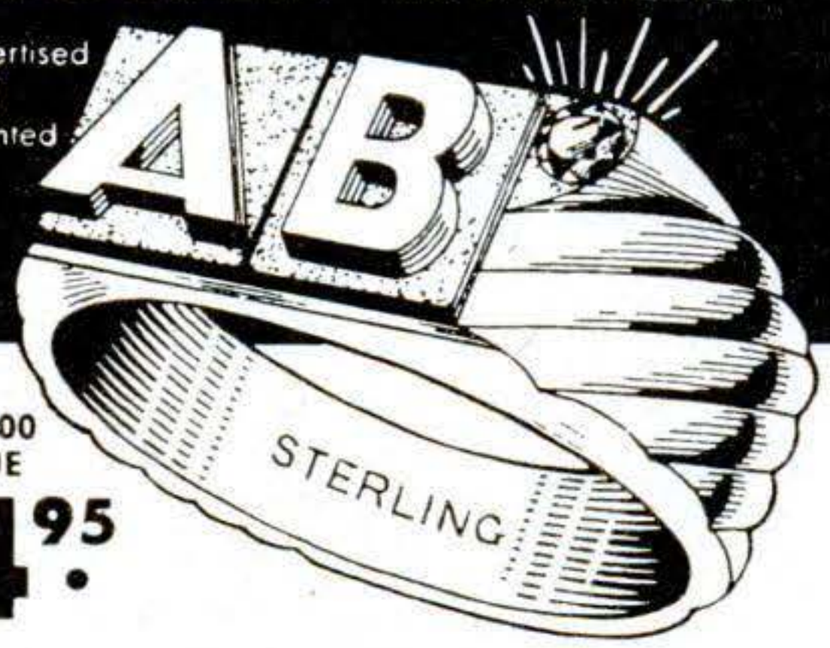

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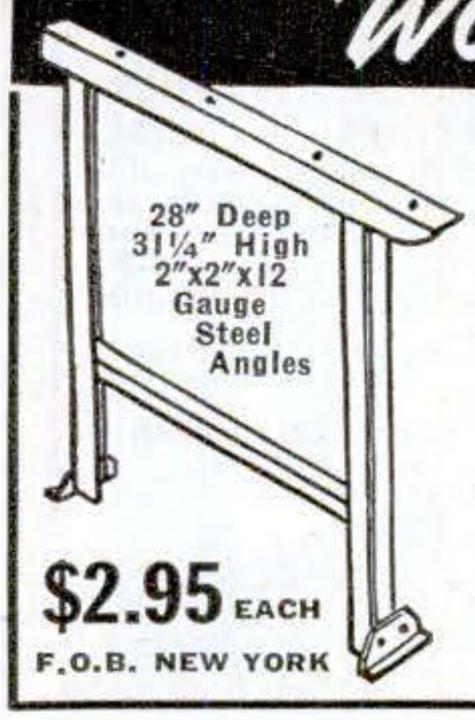

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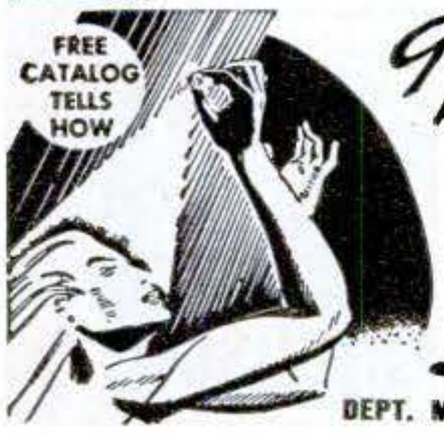

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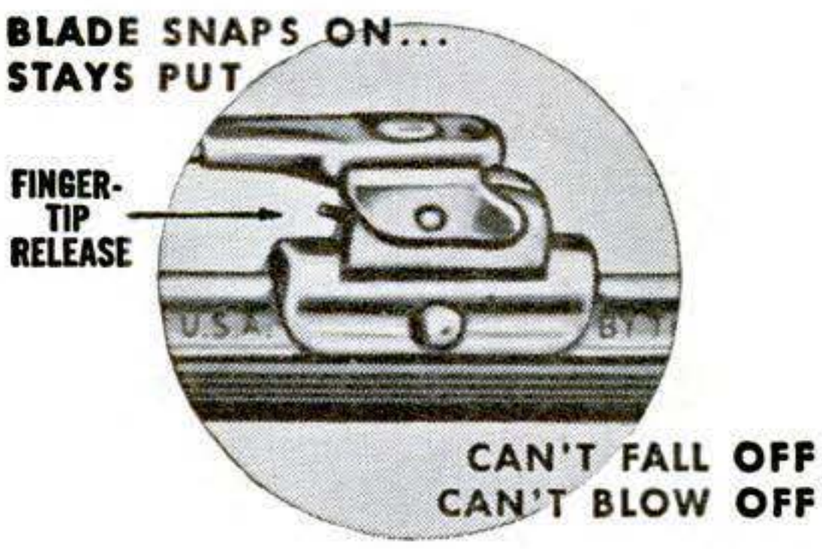

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DON'T SHOOT YOUR GAS-PUMP MAN!

He's doing the best he can. Sure, he knows how dangerous it is for you to drive your car . . . in stormy weather . . . with your dull old windshield wipers that smear and smear. He'd gladly put on for you quickly a pair of keen new ANCO RAIN-MASTER Wiper Blades and Arms. He has them—Newest Models! But he forgets to remind you? Too busy? You can't shoot him for that!

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Ask for RAIN-MASTER Windshield Wiper Arms and Blades next time you buy gas.

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3 REASONS

WHY YOU MAY NEED NEW SPARK PLUGS

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GREATER MILEAGE
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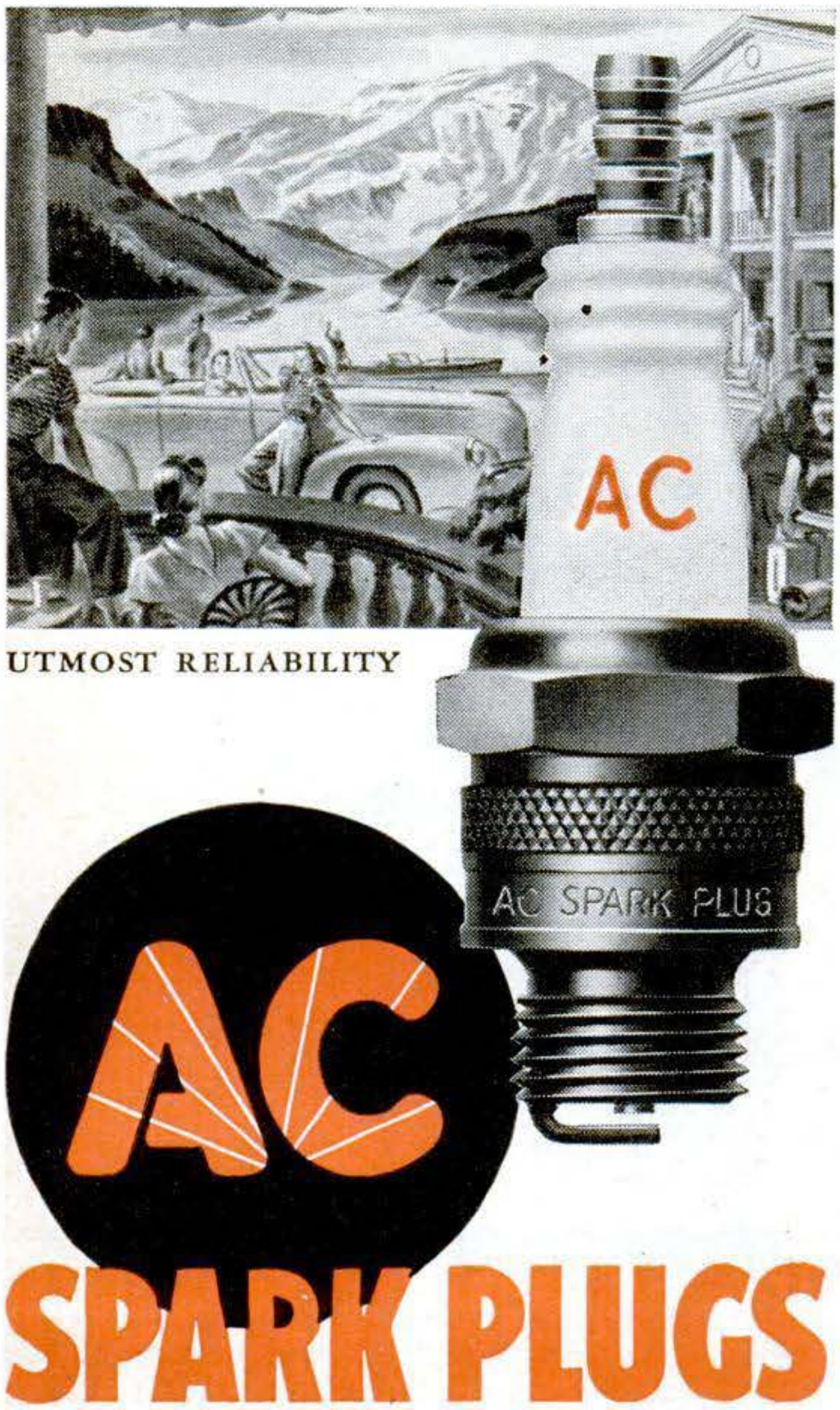
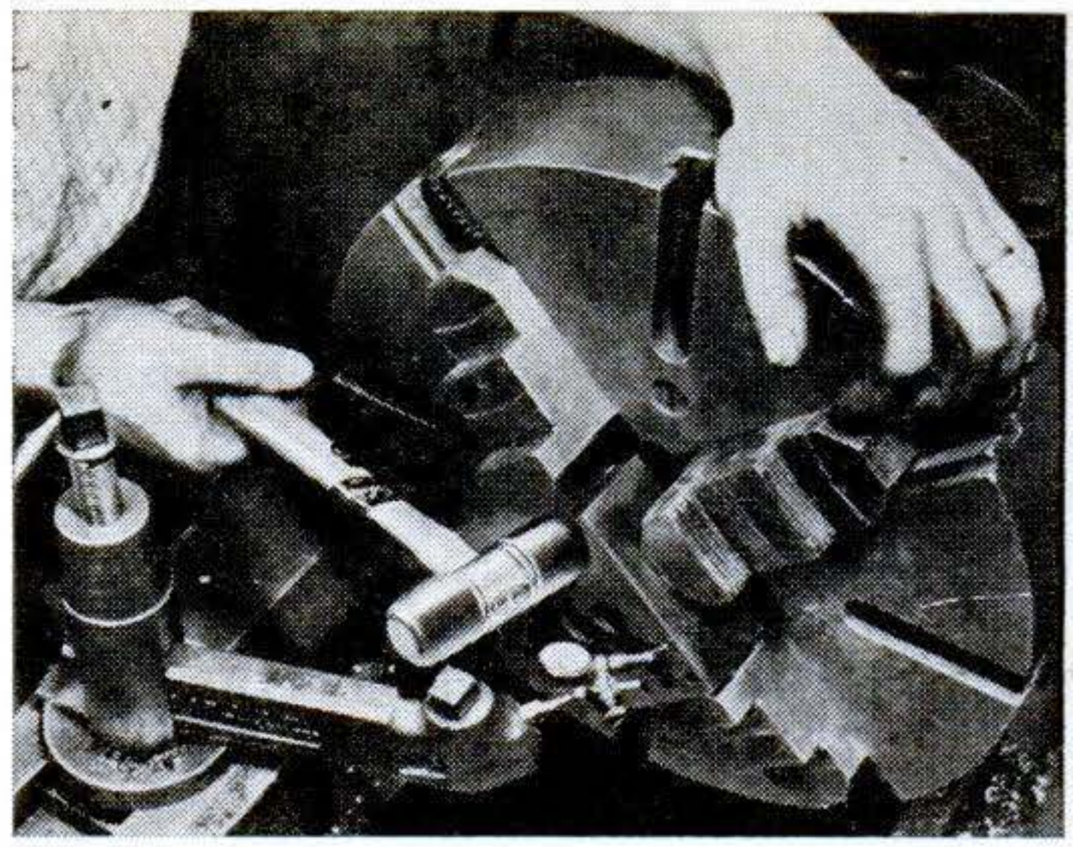
More than 2 out of every 4 new cars and trucks built since 1932 were factory-equipped with AC's —because AC's give *utmost reliability* in performance. Try the new, improved AC's in *your* car.

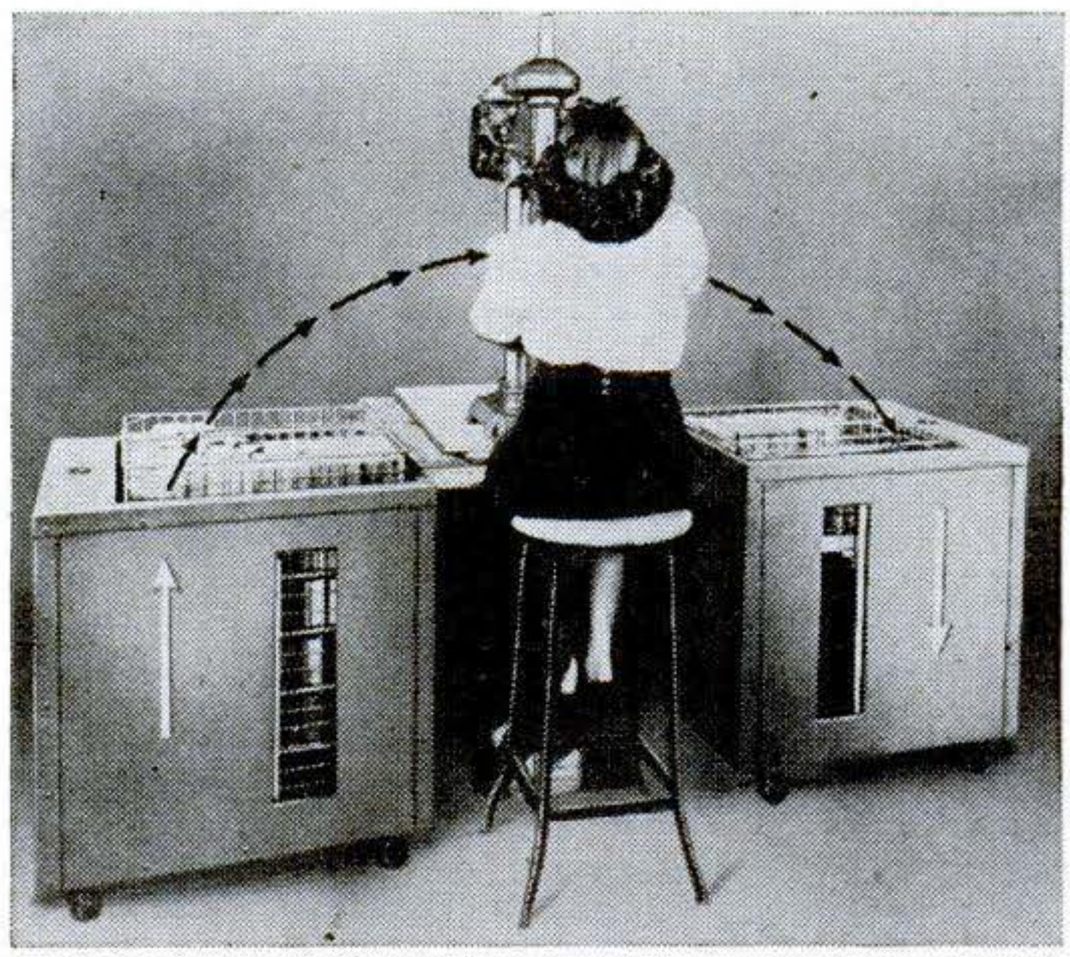
AC Spark Plug Division • General Motors Corp.





Unbreakable Plastic Hammer

An unbreakable hammer with a double head of hard plastic that will not mar flat surfaces of metal has been produced by the Schmidgall Mfg. Co., Peoria, Ill. Called the Kant-Mar, it is designed for use in machine shops and industrial and service organizations where mars, dents and blemishes on dies and fixtures must be avoided. The hammer head is lightweight, fireproof, acid-proof, nonconducting; its handle is hickory.



Material Racks on Elevators

Operators who reach to the left, pick out an object, process it, and deliver it to the right will welcome this Automatic Material Rack. A spring mechanism maintains the two racks at convenient working level. As left trays are emptied they rise; as finished parts are placed at right, those trays automatically depress. The units are manufactured by the Lowerator Division of American Machine & Foundry Co., New York.

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Magic Wand WELDER

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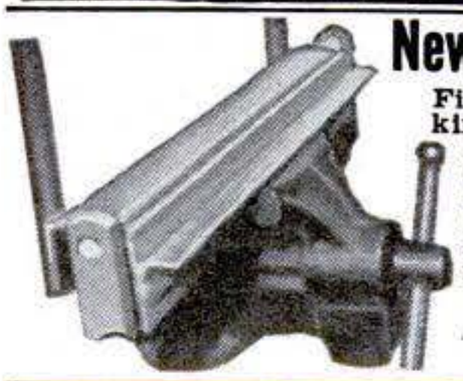

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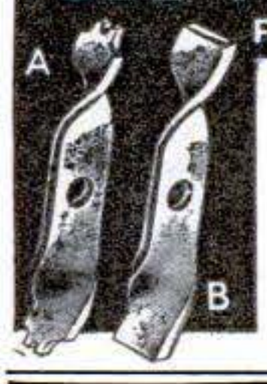
FOR JOINTING & CUTTING MOULDINGS



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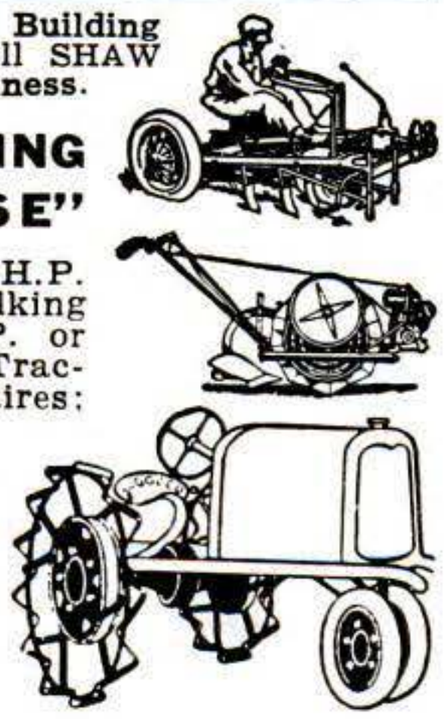

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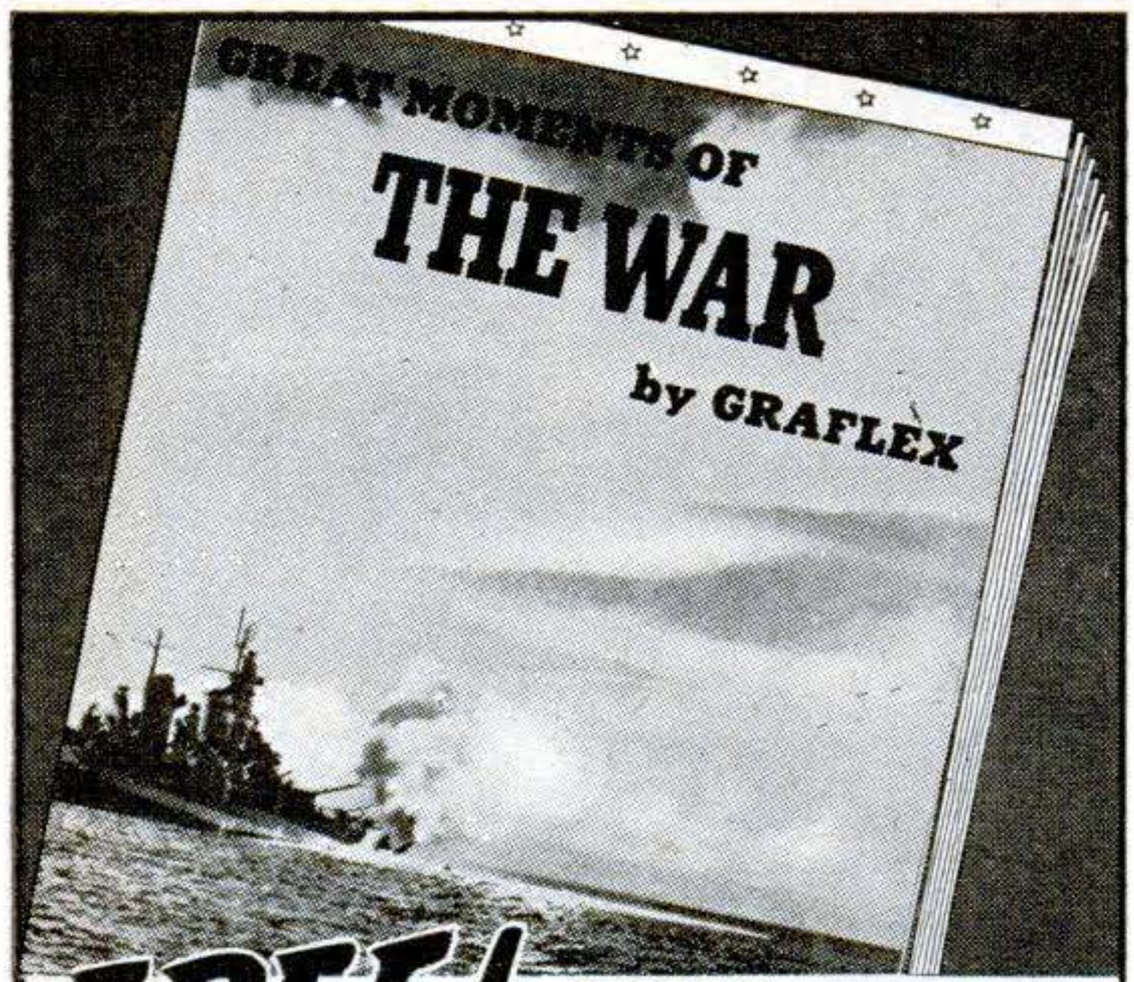

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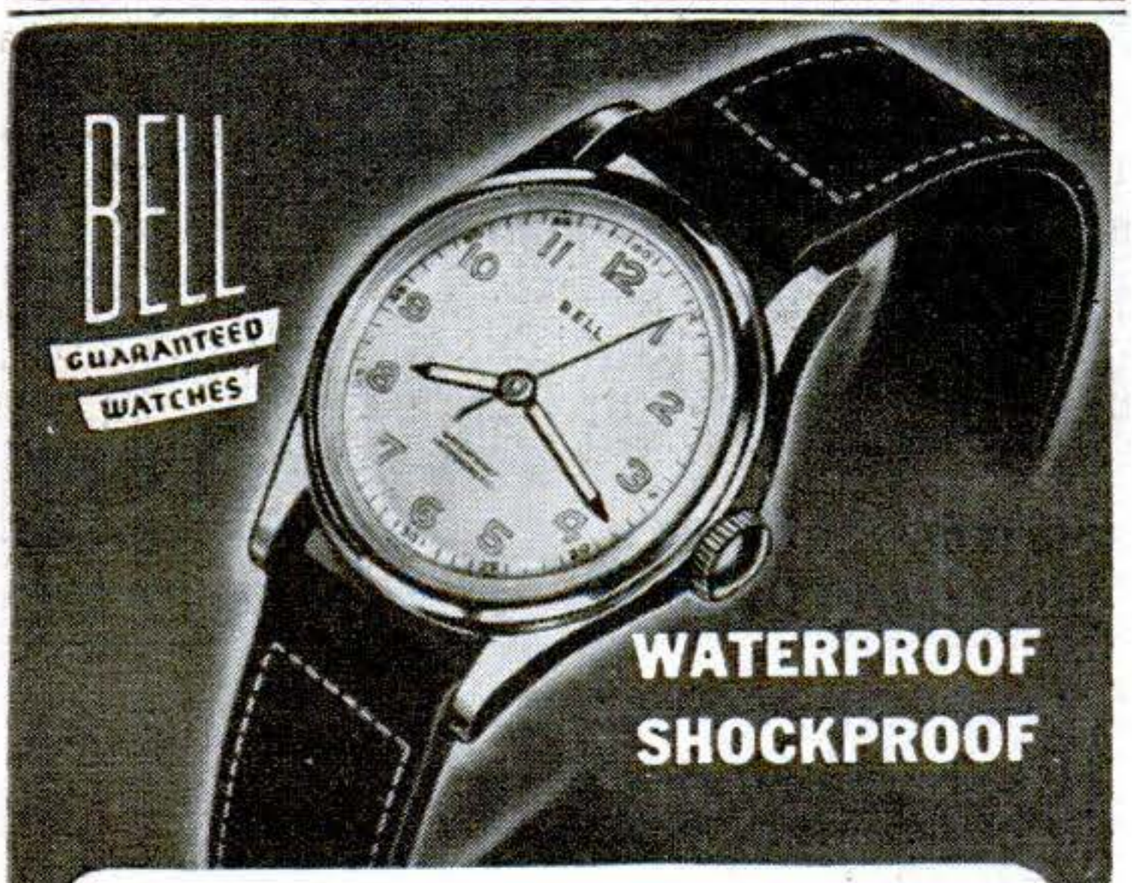

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Let us give you our prices on your aluminum castings.

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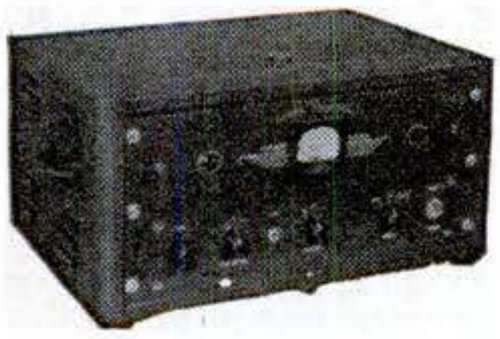

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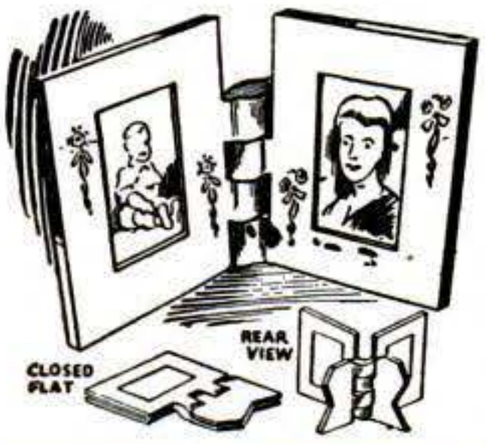

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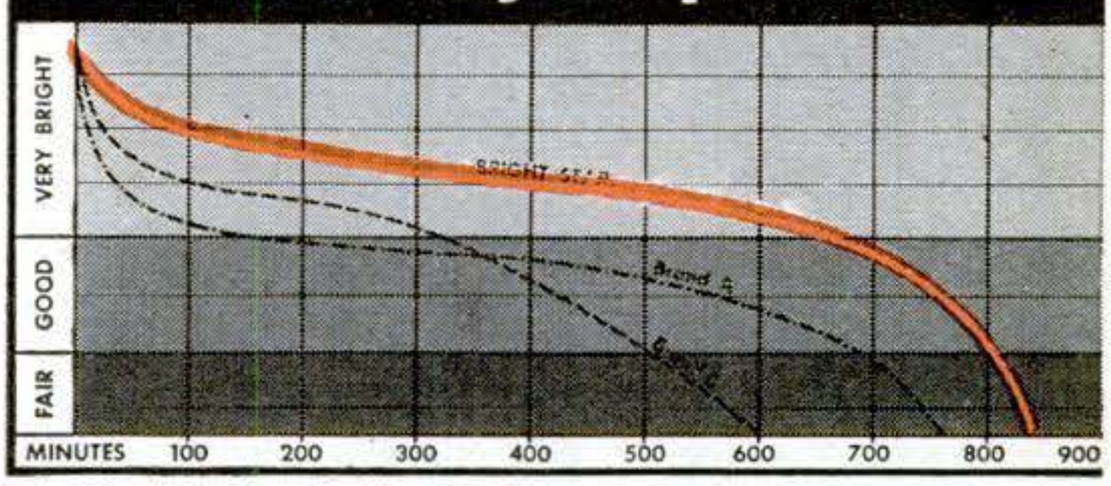
Now! tests prove-

BRIGHT STAR BATTERIES give more bright light longer

Here is your proof!



These results of vital service tests* prove that Bright Star batteries give you more *bright light* longer than the two other leading brands tested. Insist on the best —it's Bright Star by test!

**Chart based on laboratory tests conducted under government standards.*

BRIGHT STAR BATTERY COMPANY, CLIFTON, NEW JERSEY

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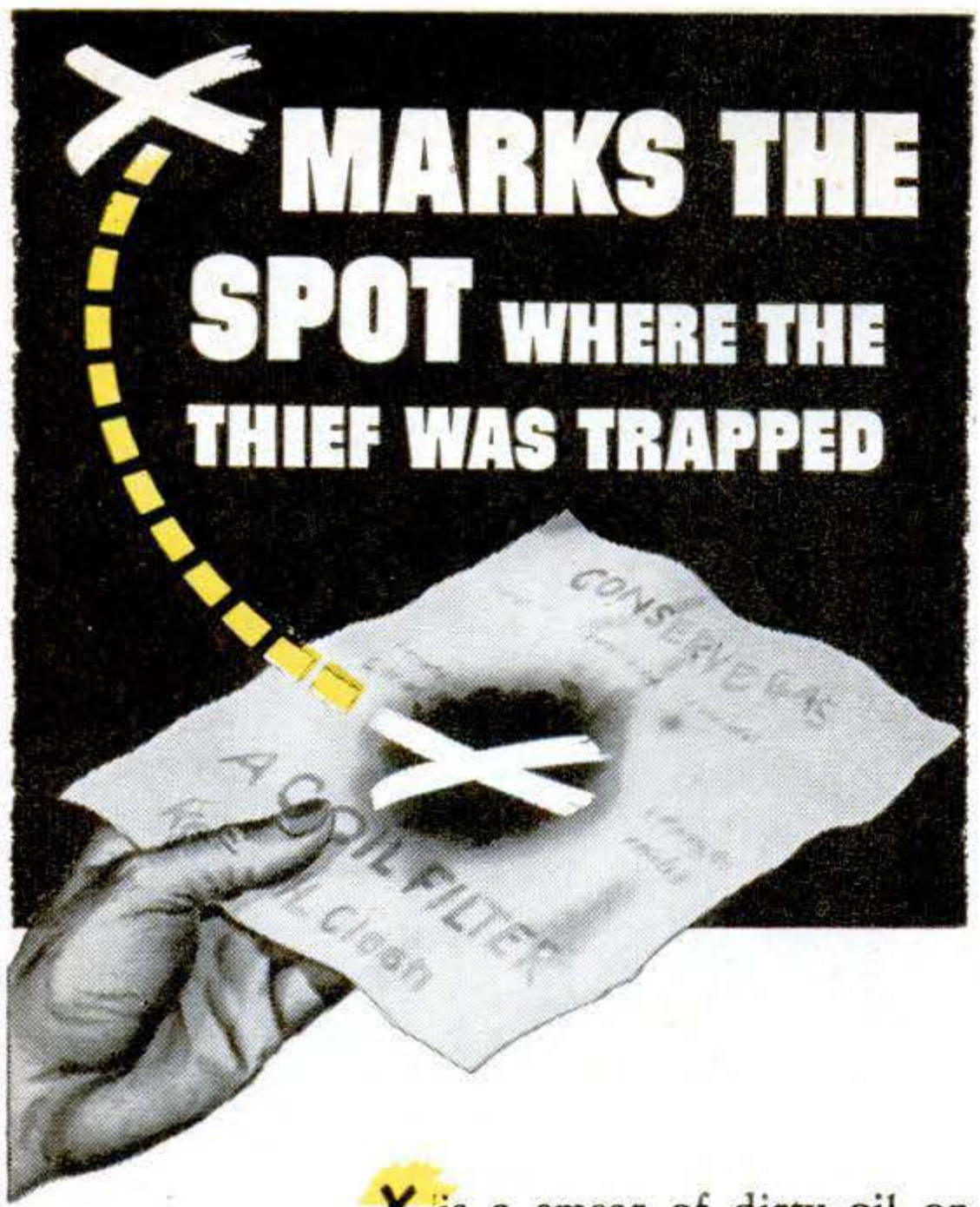

X is a smear of dirty oil on an AC Oil Test Pad — oil from a car whose owner didn't know he needed an oil filter. The evidence shows clearly on the white pad.

You can get this oil test FREE—and in a jiffy —at any official AC Oil Filter Service Station. The attendant simply wipes the dipstick on the Pad, instead of a rag, and you can see for yourself whether your oil is safe to use.

Dirty oil is a power thief. It clogs piston rings and slots—makes valves stick—hastens engine wear—wastes fuel and oil—steals more and more power as the days go by.

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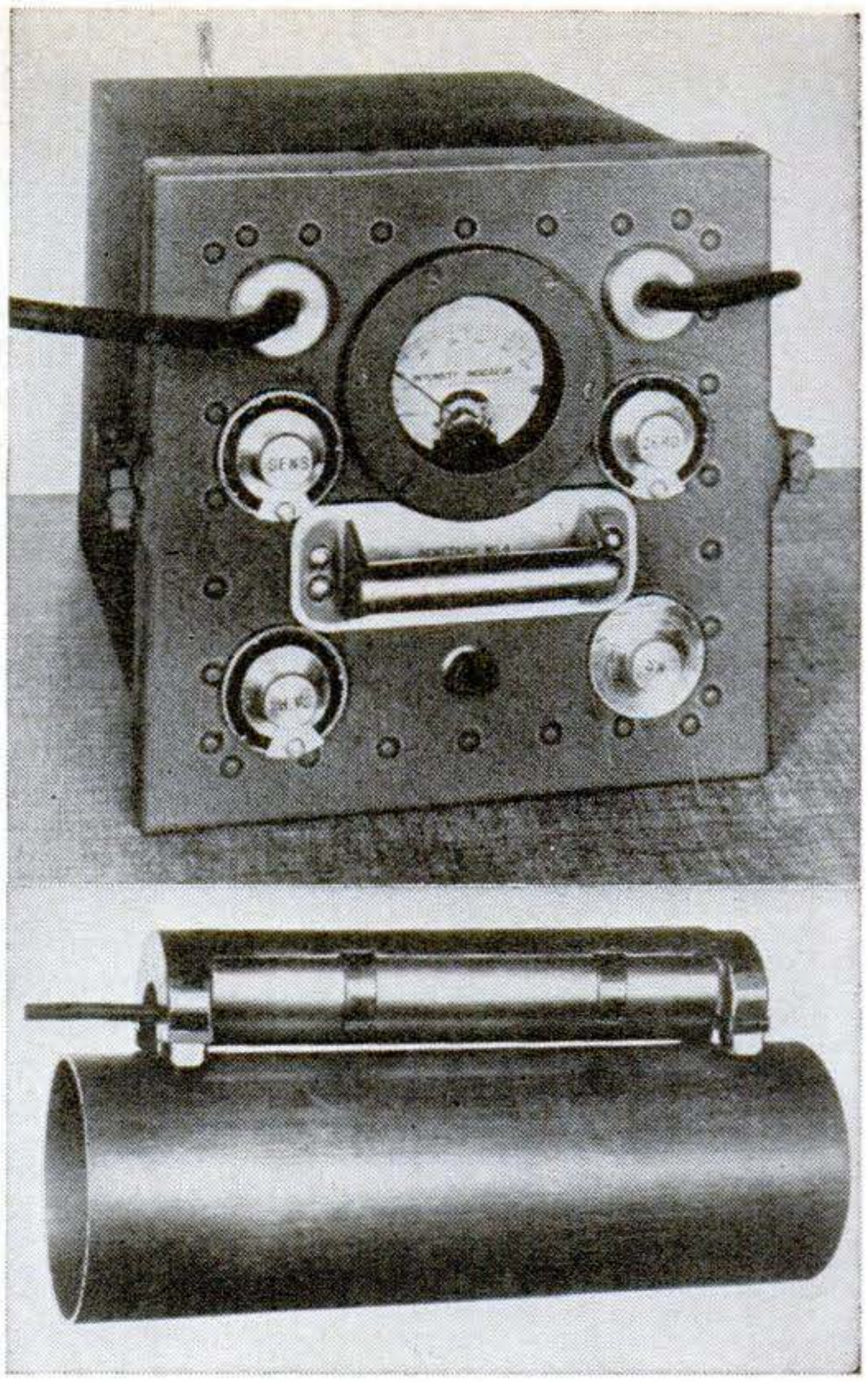
So see your AC Official Oil Filter Service Station today and trap the thief that's stealing your power. Look for the sign shown below.

AC SPARK PLUG DIVISION—GENERAL MOTORS CORPORATION



Radium "Looks" Through

MAINTENANCE of equipment in safe condition, particularly in the petroleum industry, has been simplified by a radium instrument called the Penetron. The Texas Co. developed it to save the trouble of drilling holes at suspected points in oil-refinery equipment and testing wall thicknesses with calipers.

Now, instead, the Penetron instrument, using one milligram of radium, directs gamma rays through the area being measured. Reflected rays are picked up by a detector, producing minute current discharges that are amplified and measured by reference to calibration curves.

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UNPOLLINATED dates, heretofore a loss to U. S. growers, are now ripened in two to four days if treated with heated air saturated with moisture at from 120 to 135 degrees F.

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insure accuracy — tell tension as bolt is tightened...

WHERE specifications call for accurate, *uniform* stud or bolt tension, Torqometers should *always be used.* "Guesswork" tightening is an open invitation to all the troubles that follow mechanical distortion . . . wasted power, dangerous wear, breakage of parts. Even highly skilled mechanics cannot be expected to approximate specified pressures.

With Snap-on Torqometers any worker can tighten bolts to the exact foot-pound of tension *every time...* and on delicate mechanisms, to the *exact inch pound.*

He *sees* the applied torque as the bolt is tightened . . . as easily as reading a watch.

Throughout industry, Snap-on Torqometers are being adopted as standard wrench equipment for precision assembly and maintenance operations. Available in a complete range of sizes from zero to 30 in. lbs., up to 2,000 ft. lbs. Torqometers are part of the complete line of more than 3,000 Snap-on tools, available everywhere through Snap-ons nation-wide direct-to-user tool service.

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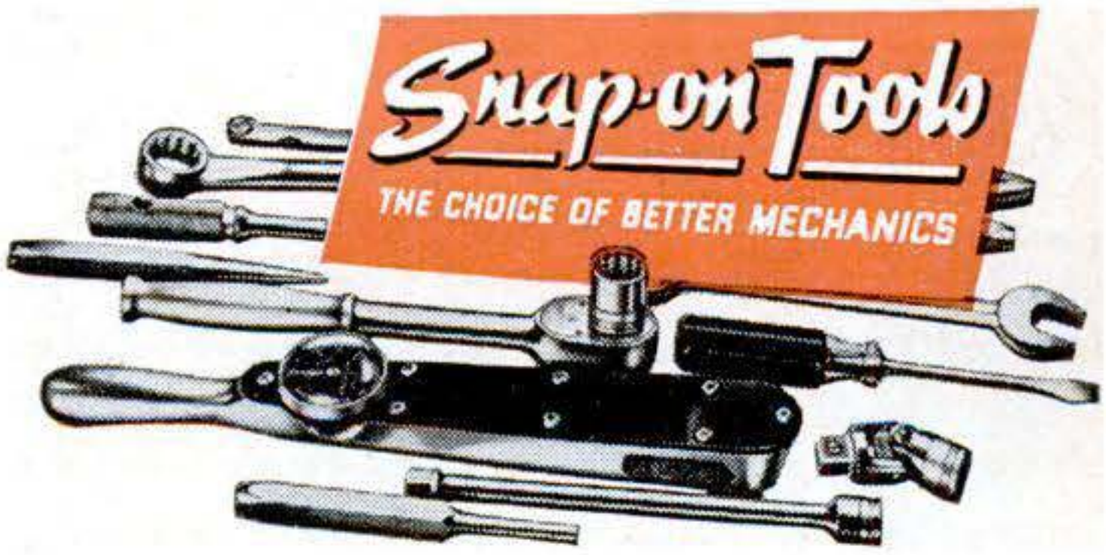

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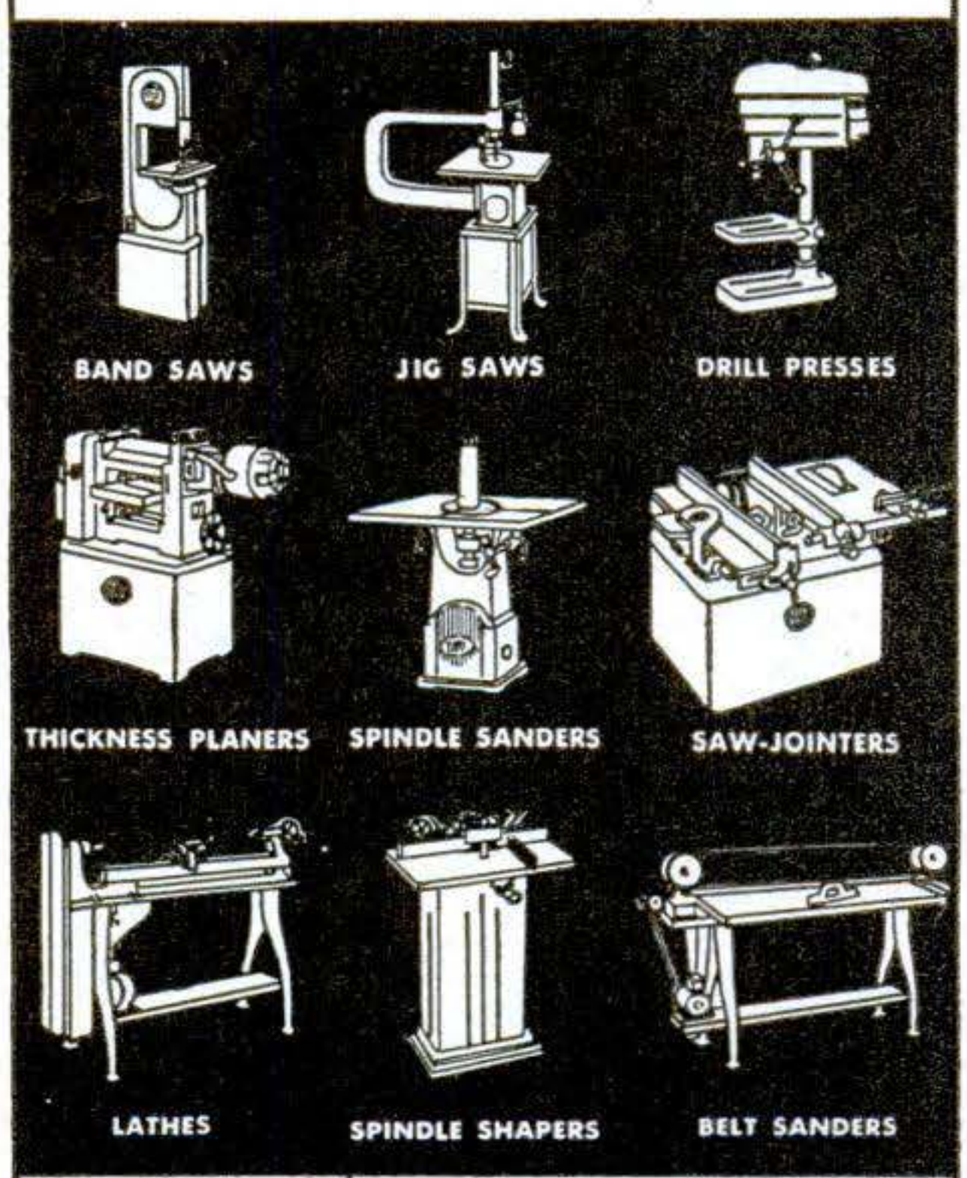
for shop men and homecraftsmen.



Write for literature on this versatile, low-cost, sturdy line.

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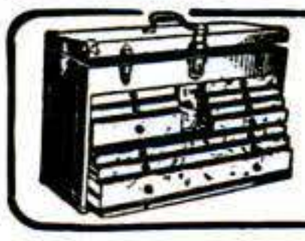

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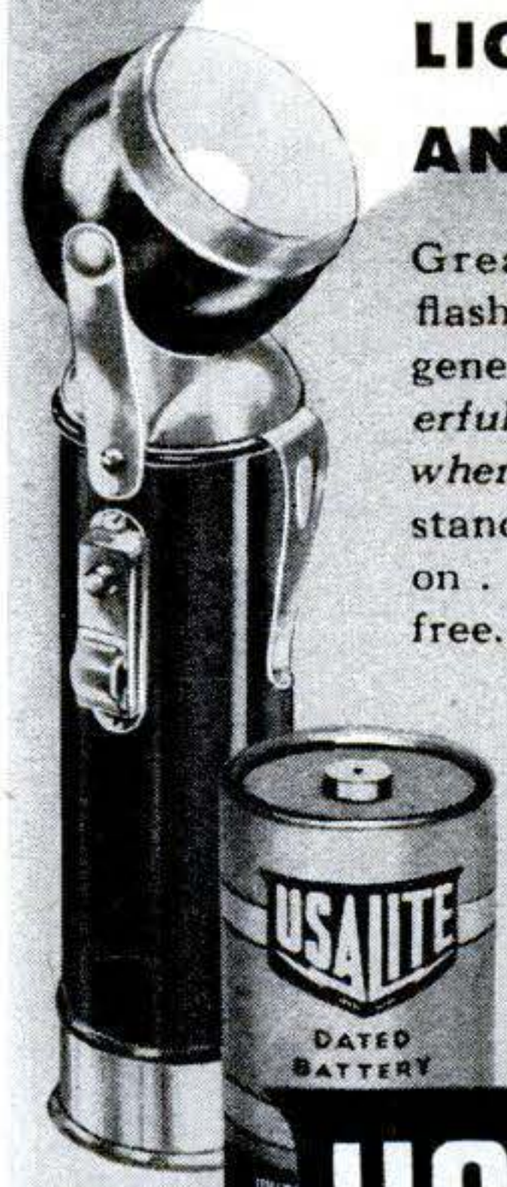

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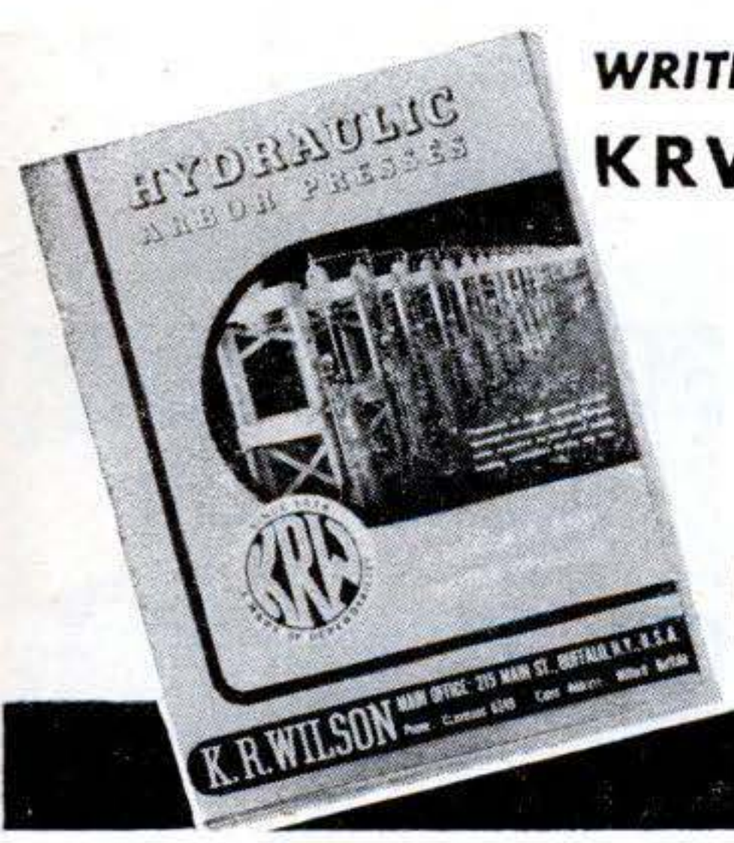

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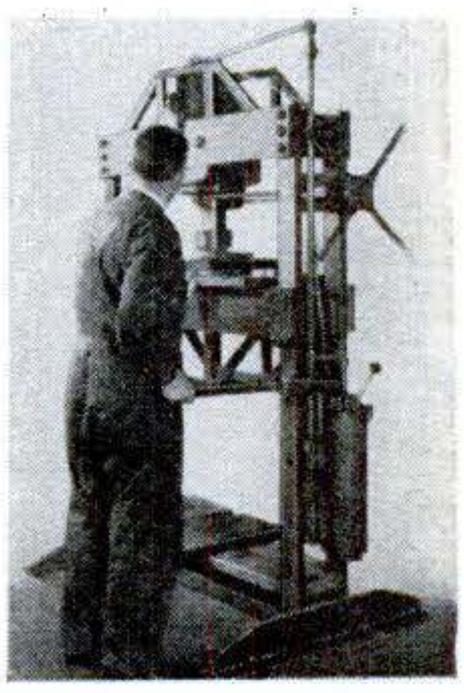

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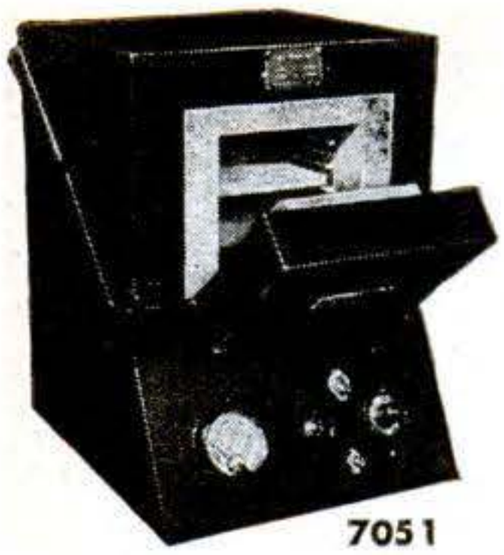

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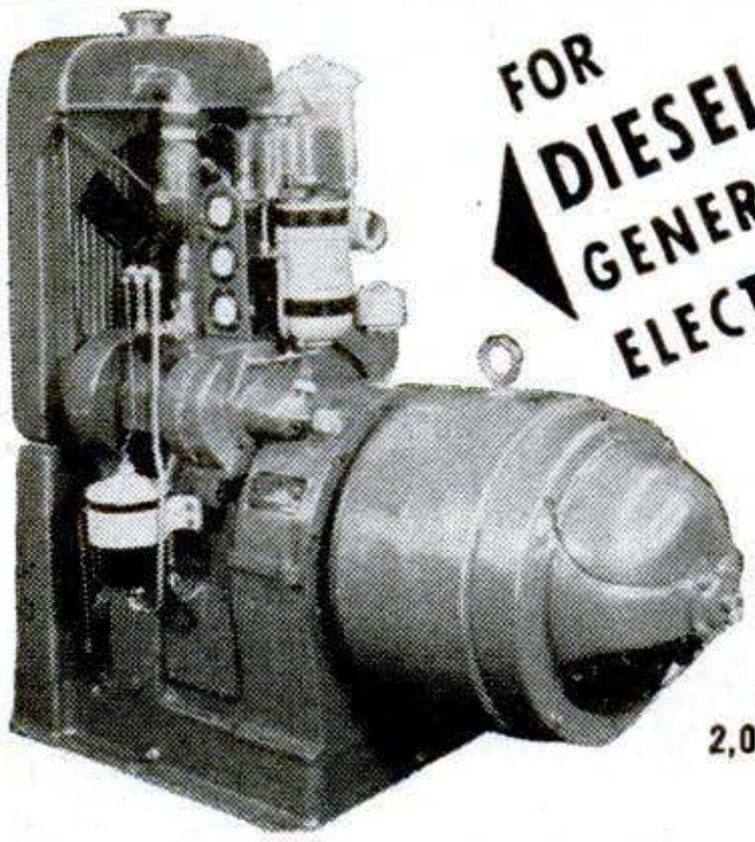

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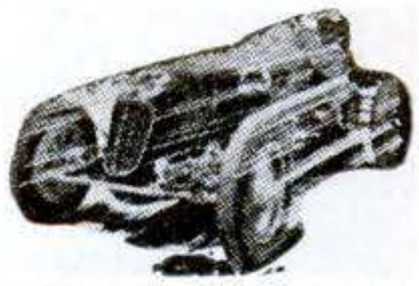

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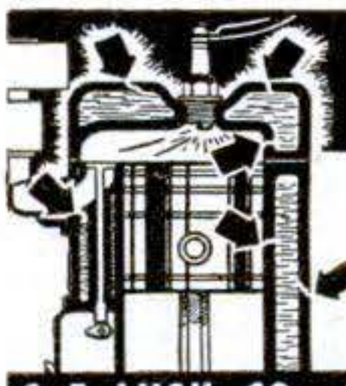

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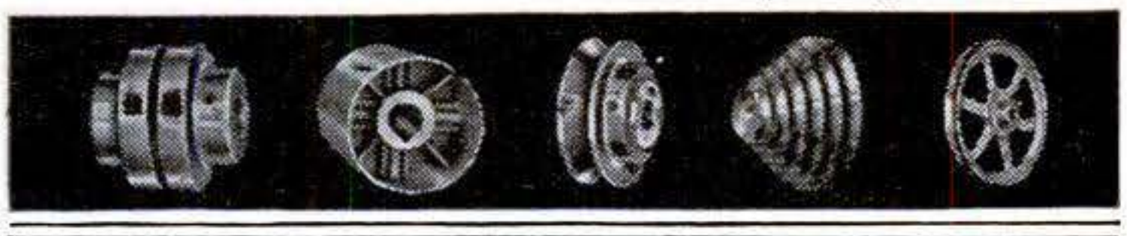

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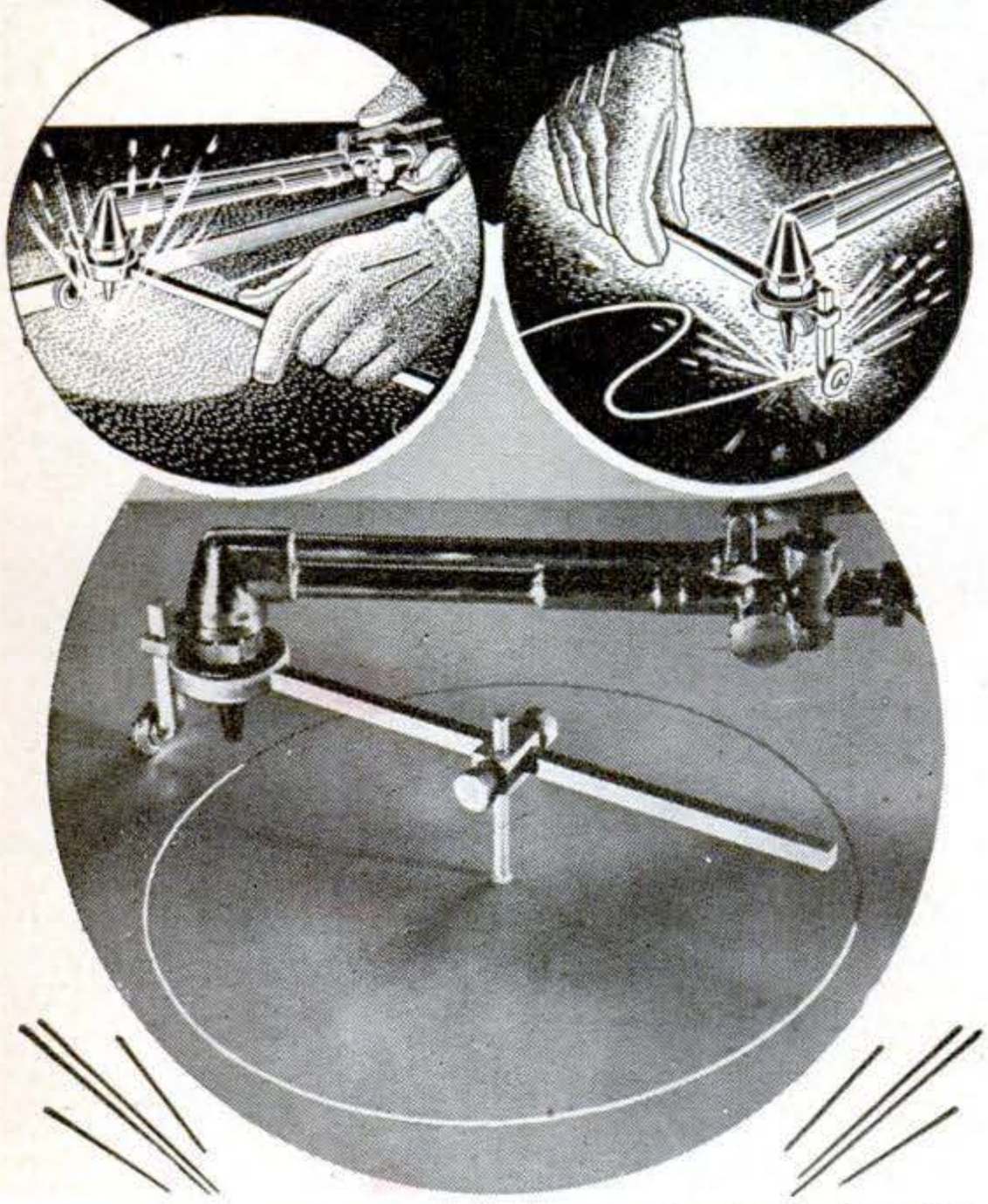

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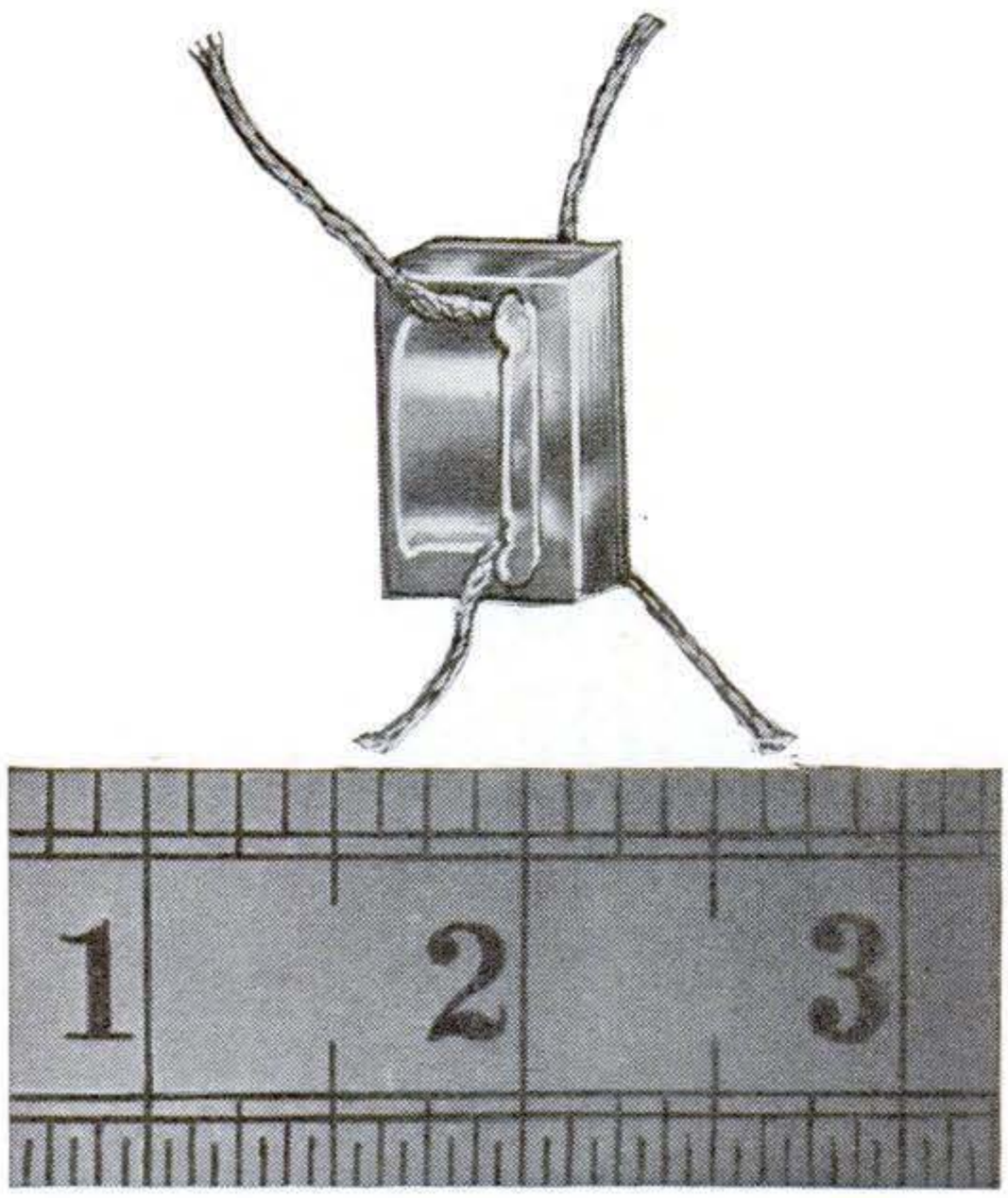

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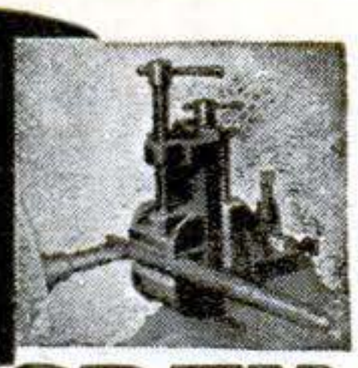

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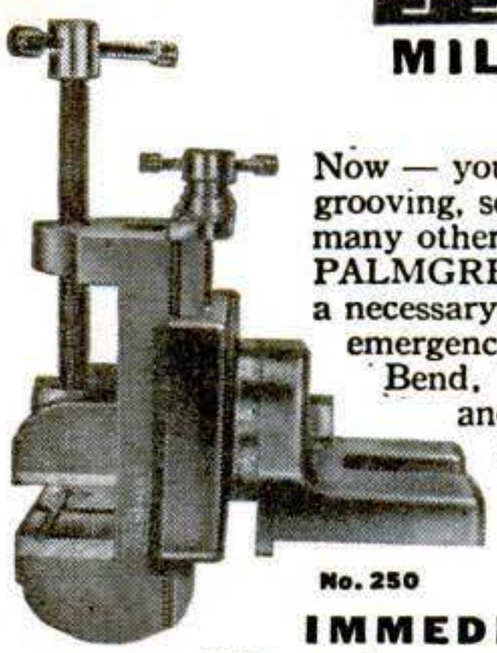

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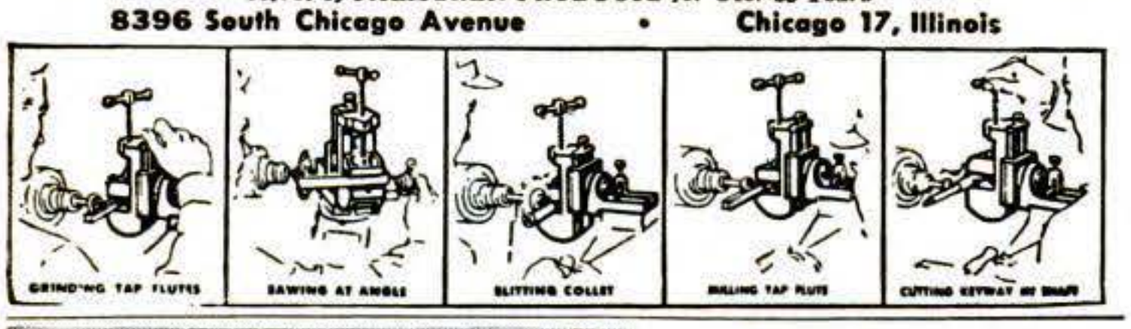

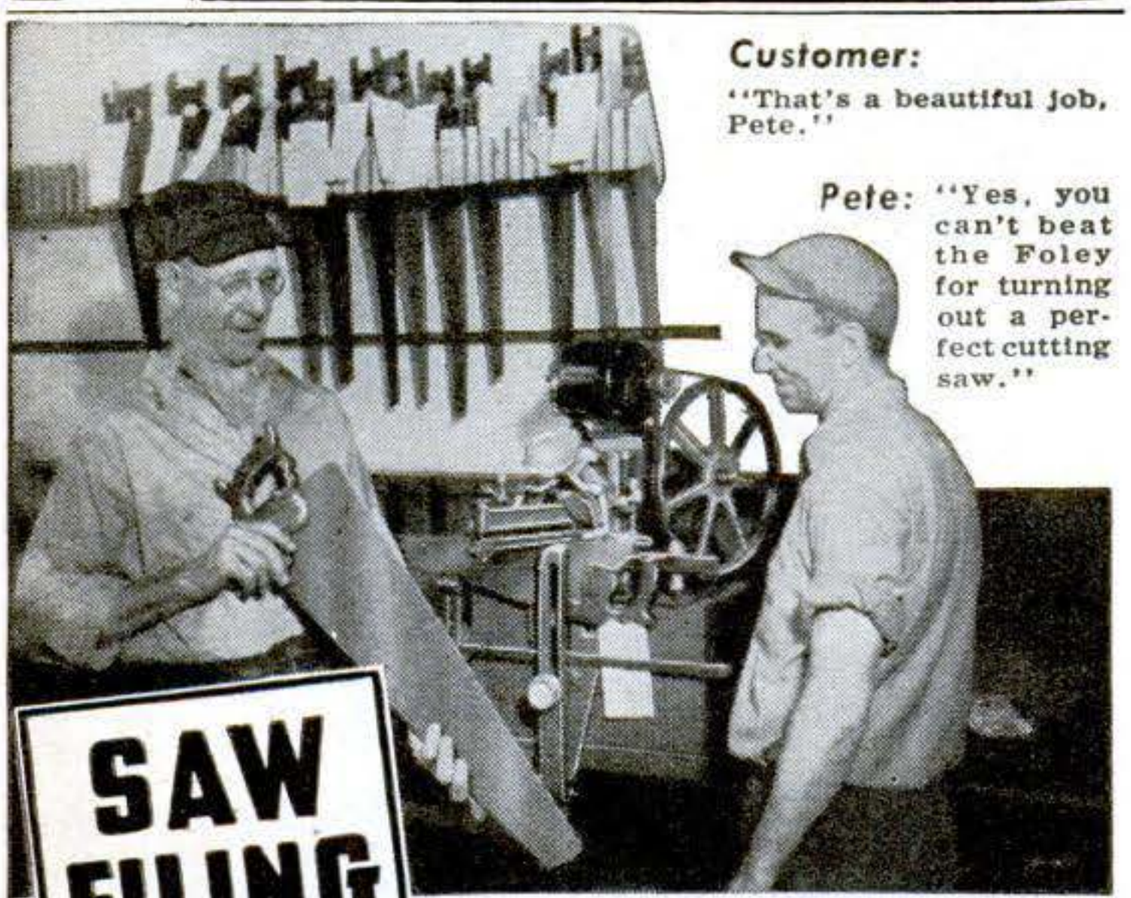

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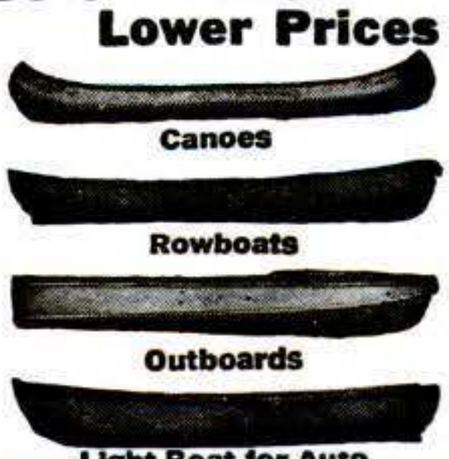

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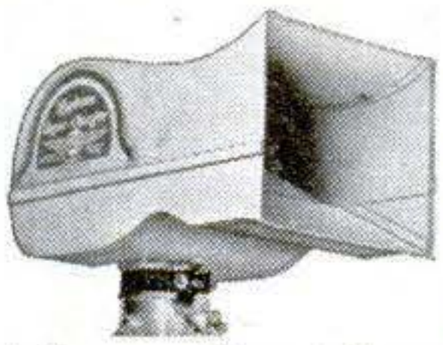

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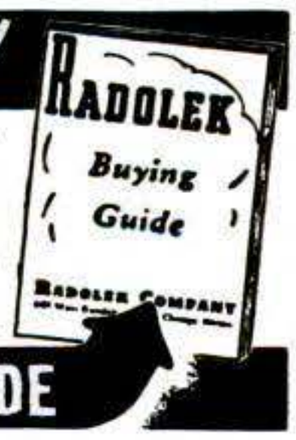

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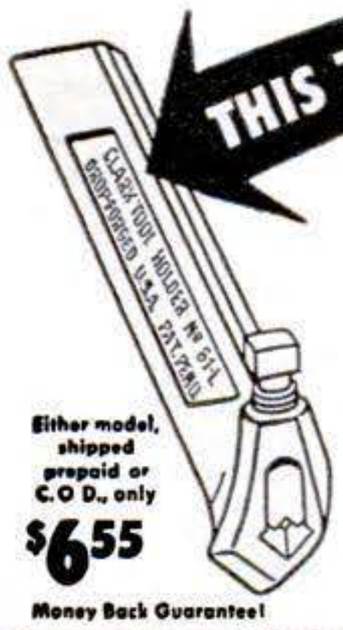

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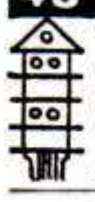

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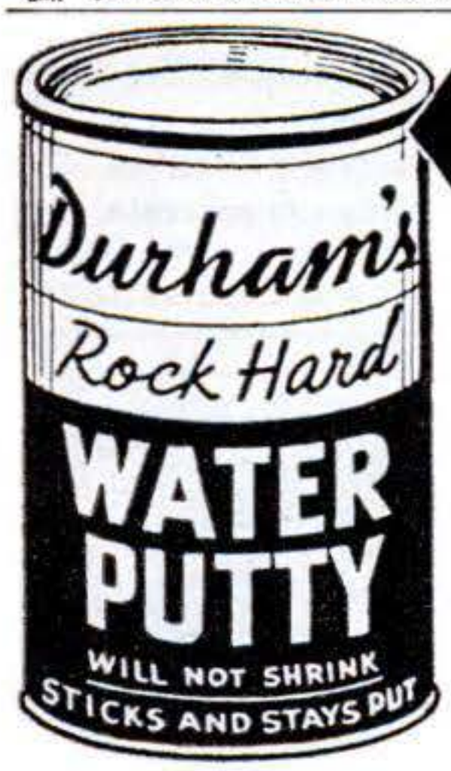

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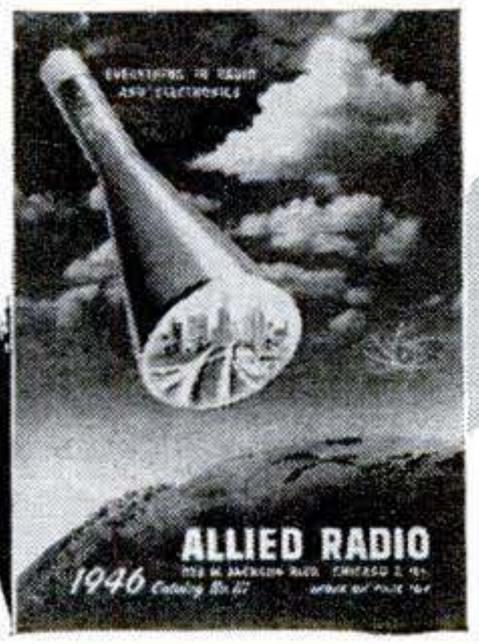

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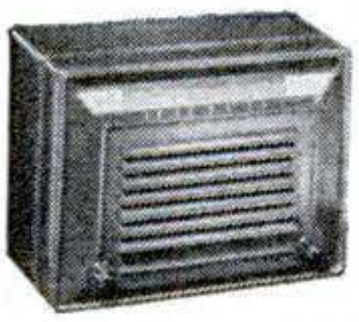

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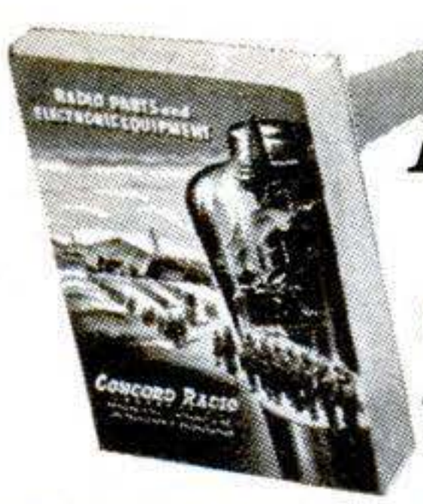

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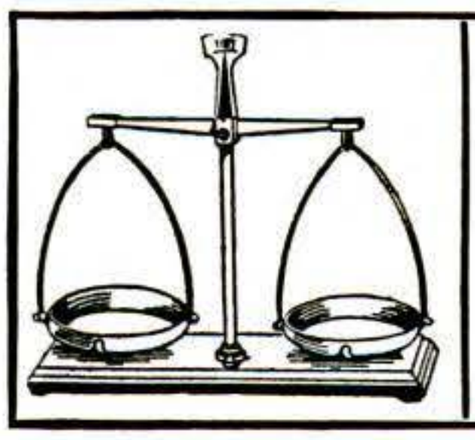

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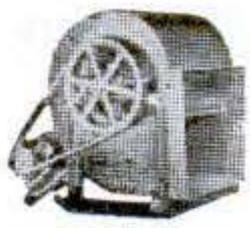

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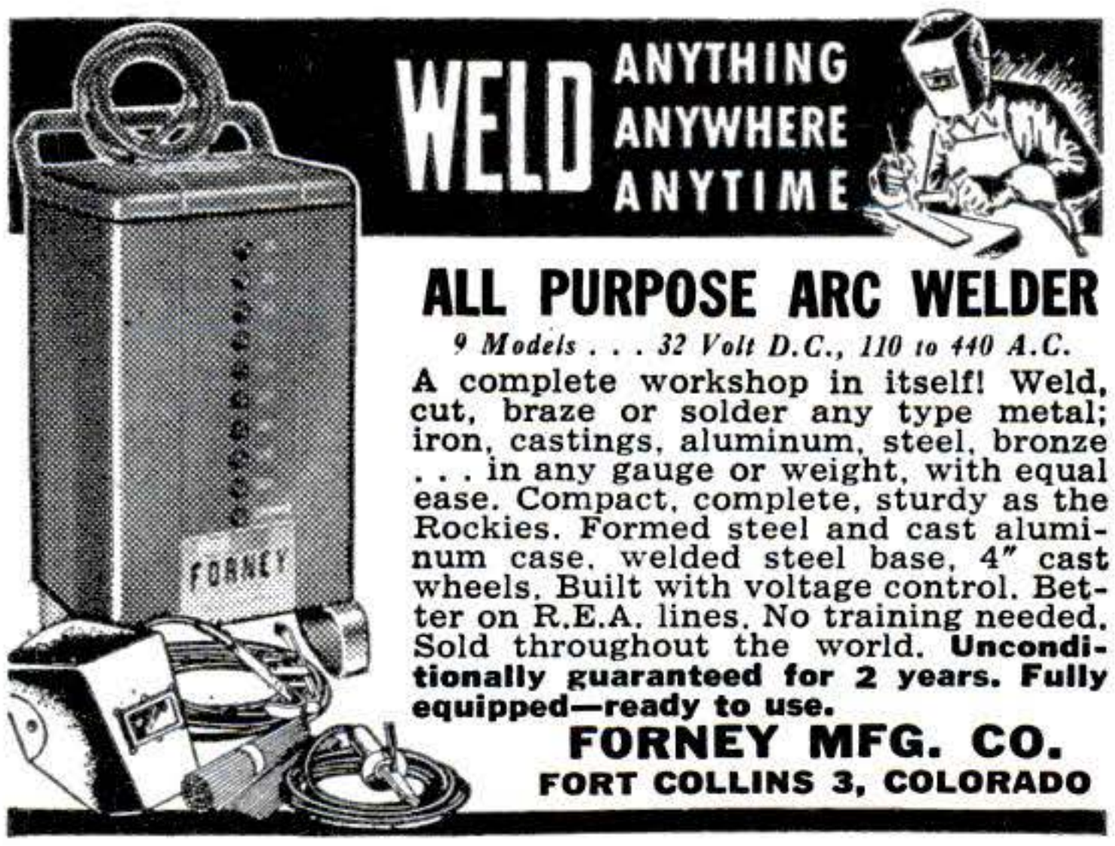

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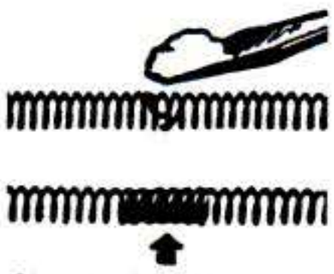

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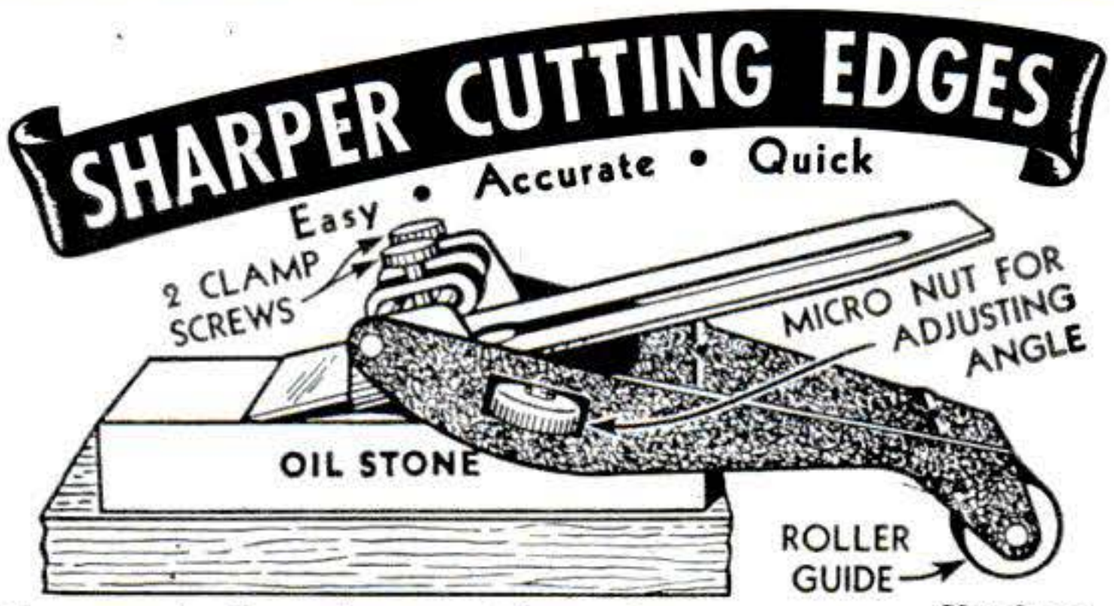

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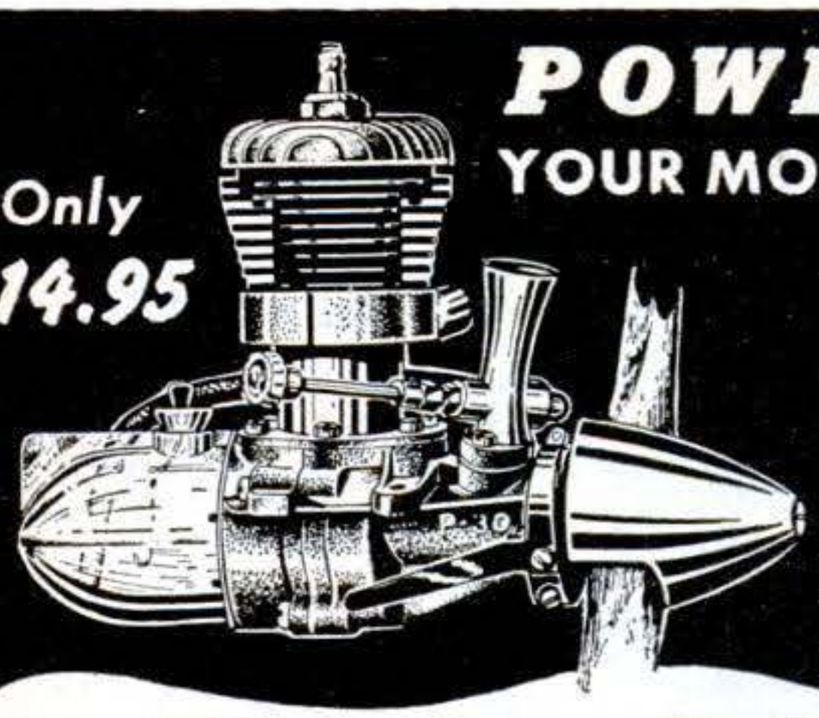

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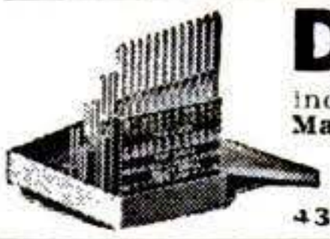

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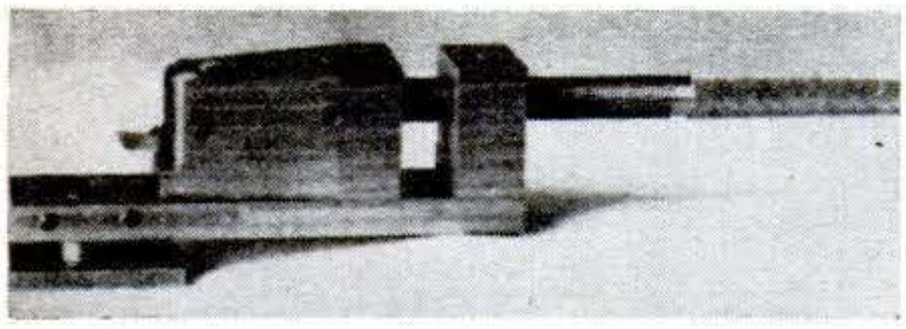

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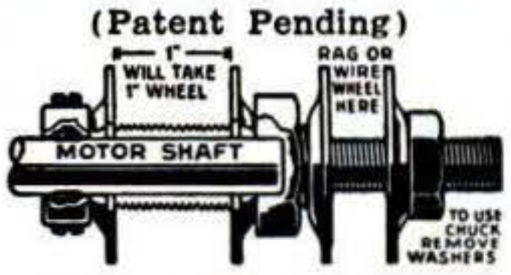

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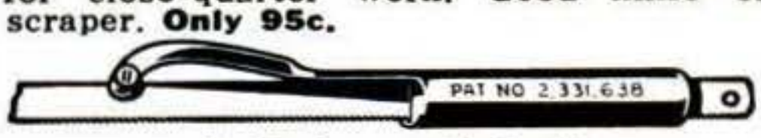

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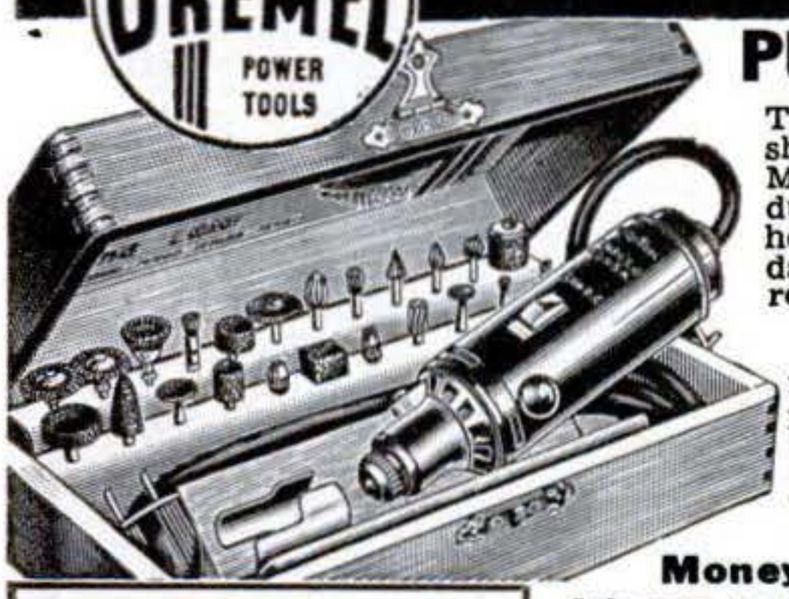

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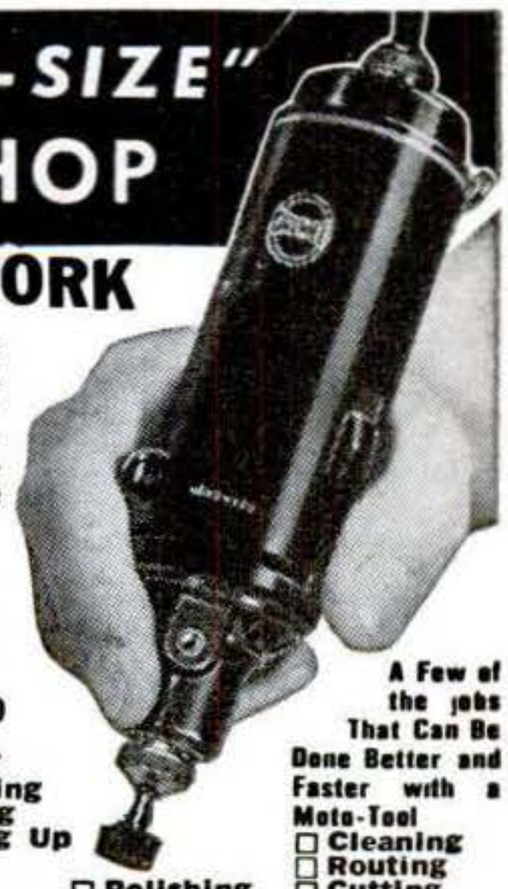

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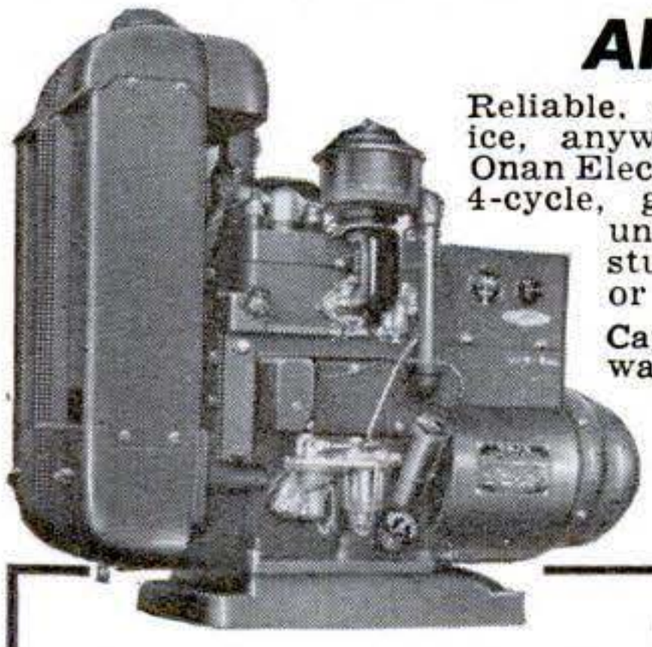

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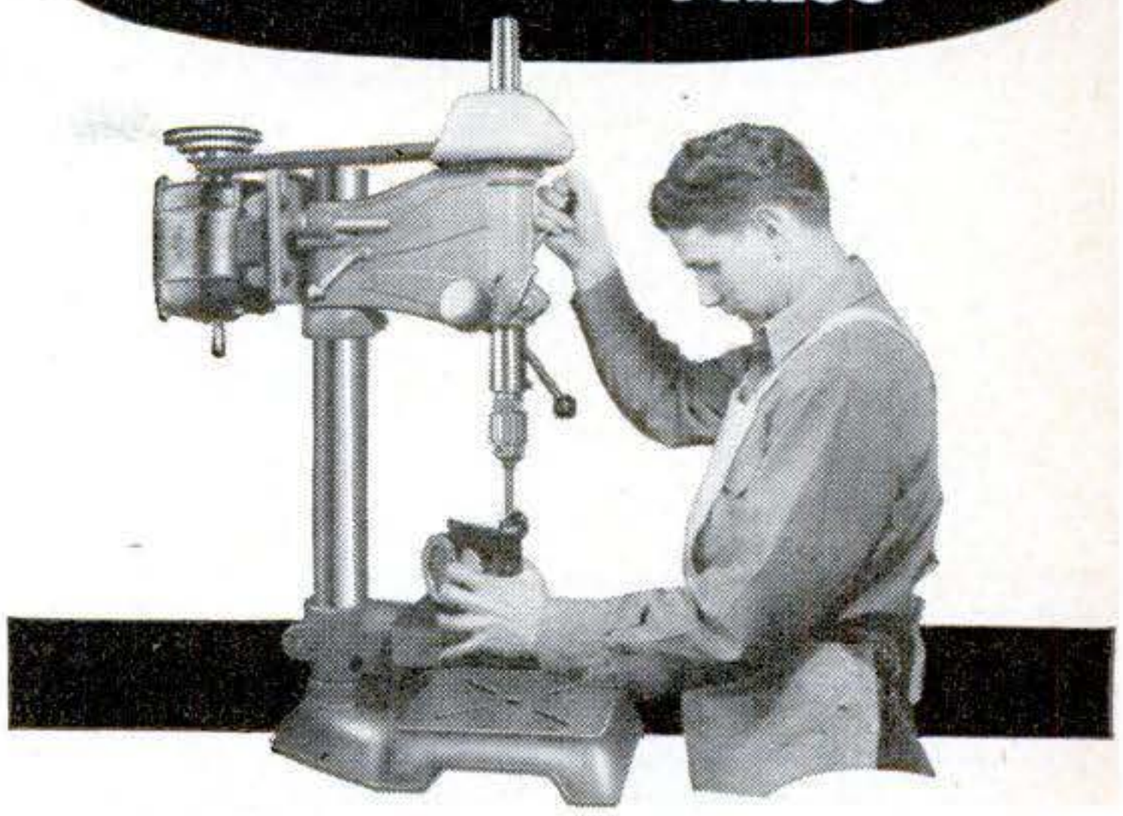

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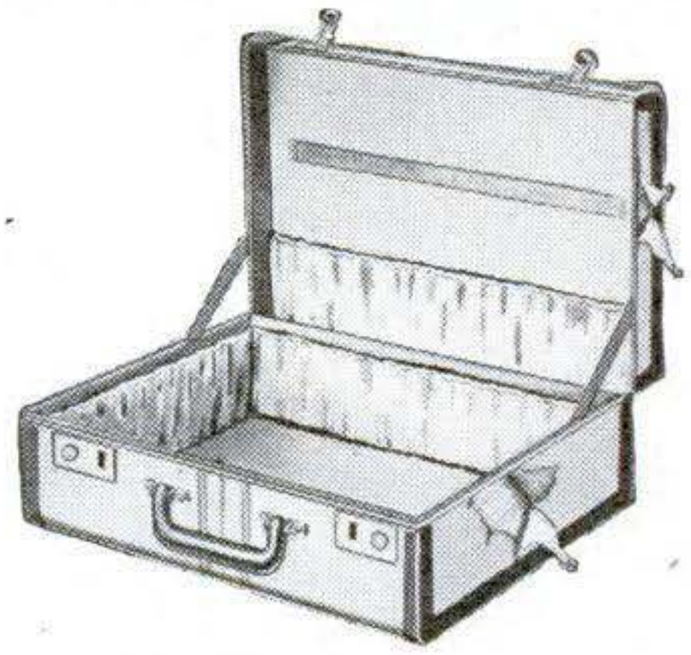

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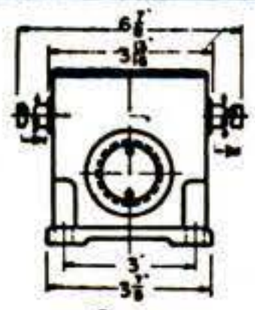

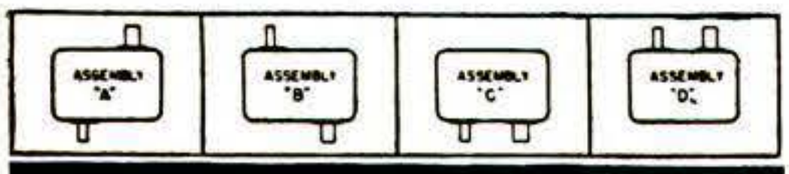

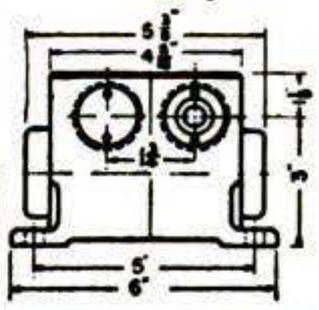

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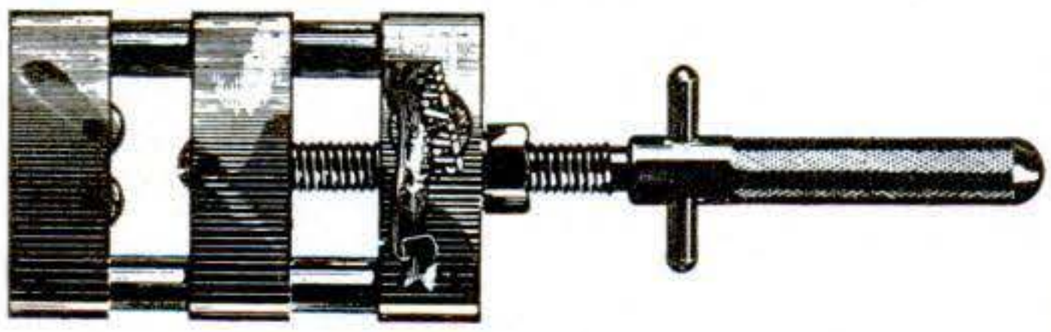

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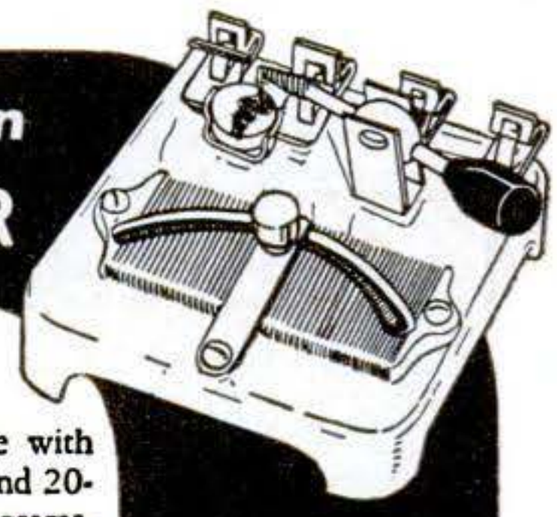

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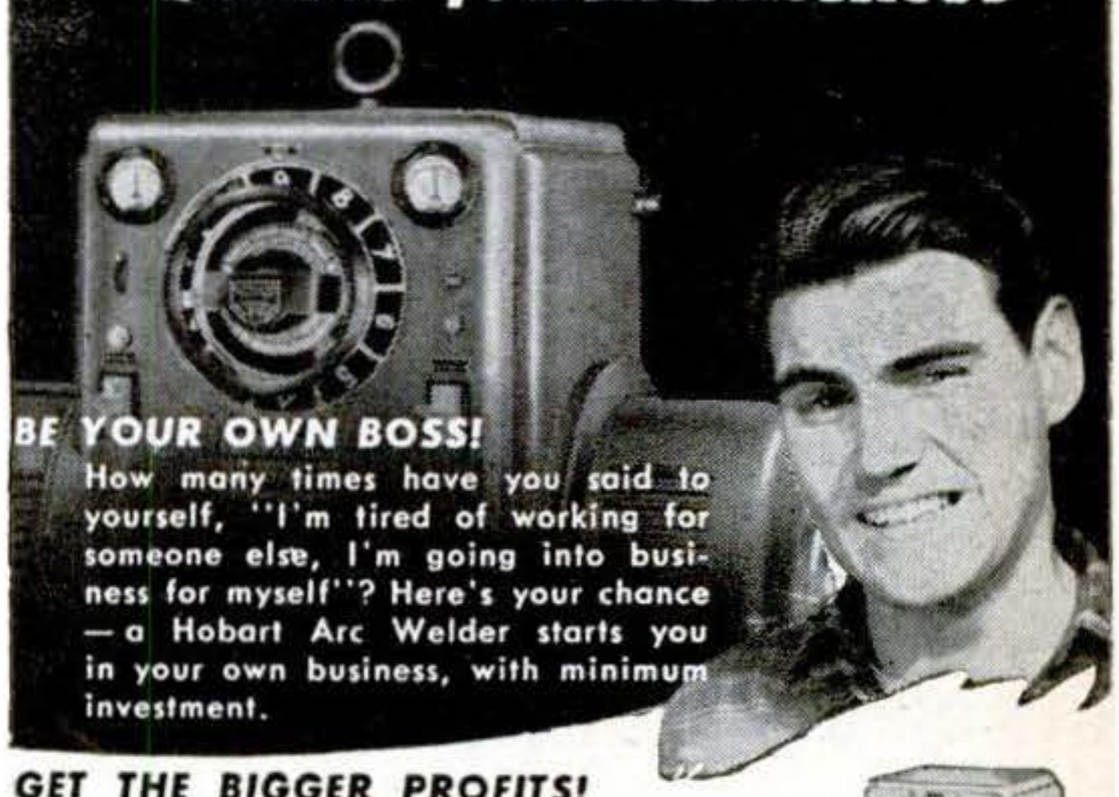

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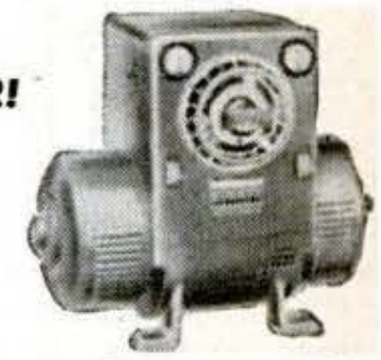

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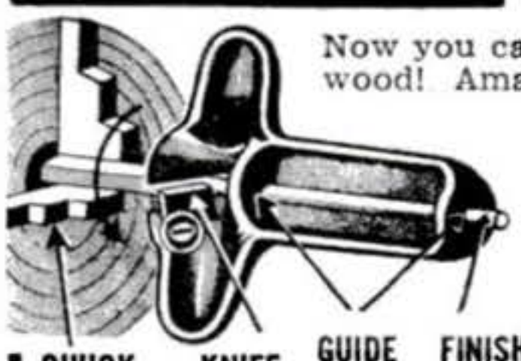

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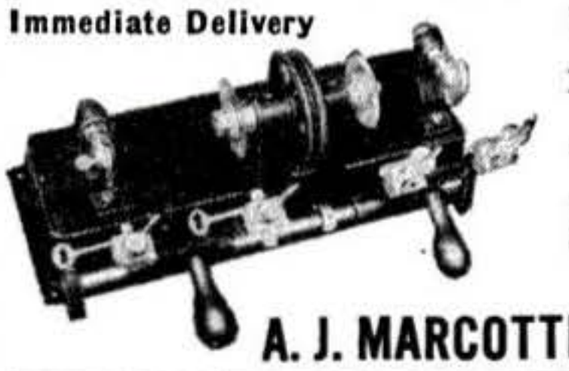

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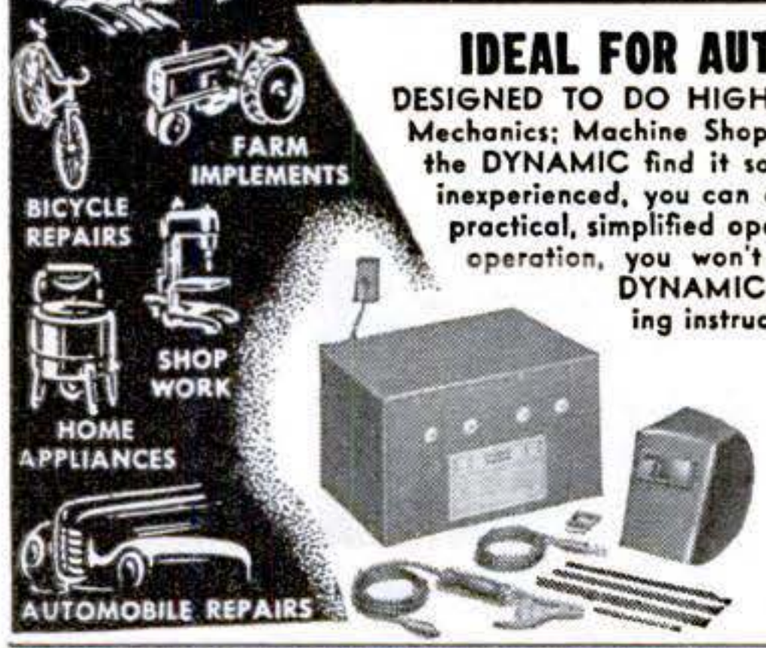

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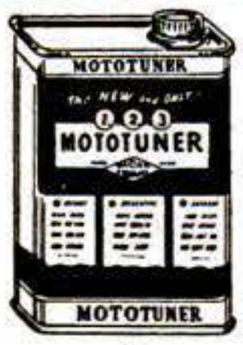

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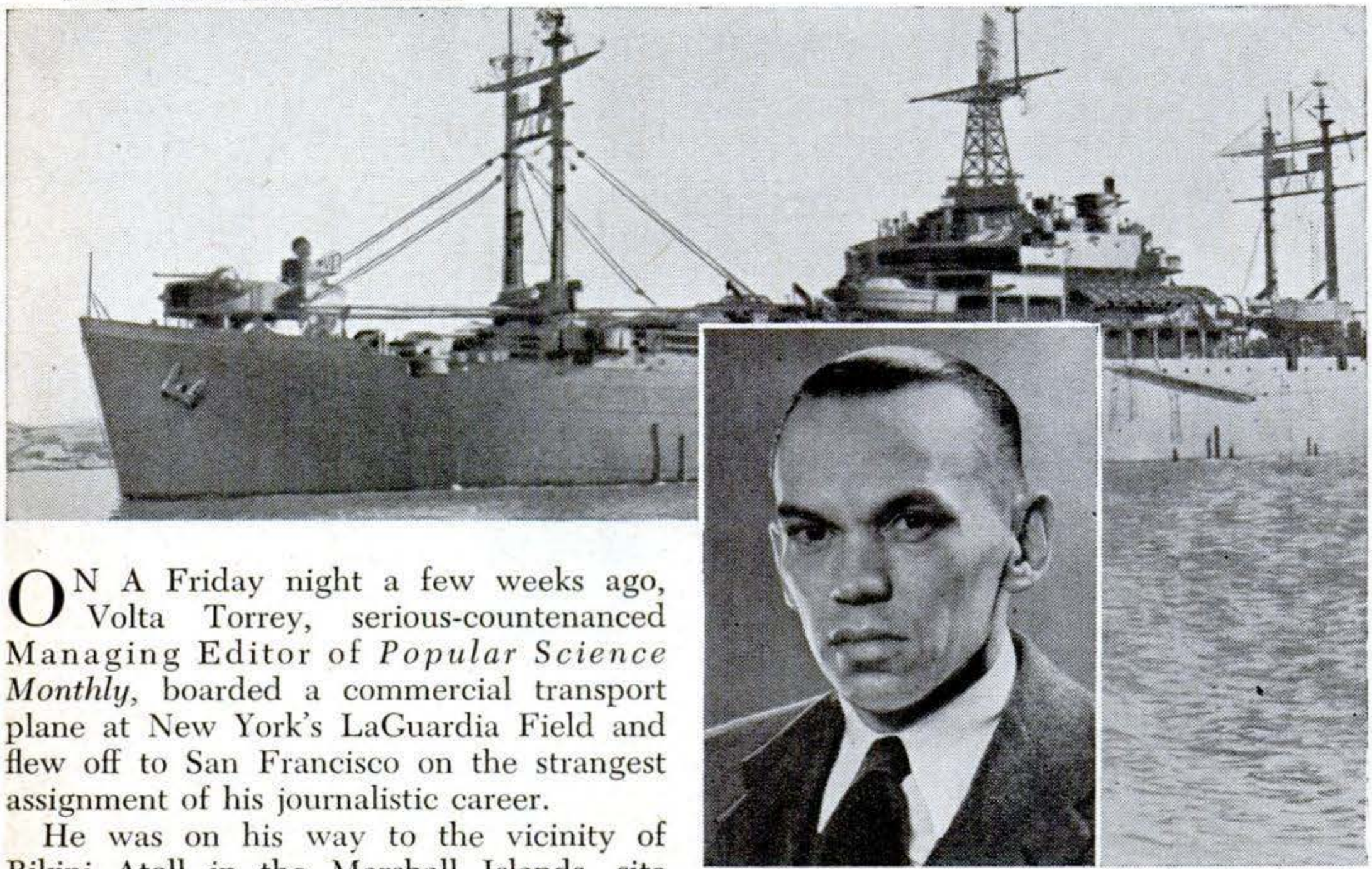
TO: Reader
FROM: Editor

Torrey at Bikini



ON A Friday night a few weeks ago, Volta Torrey, serious-countenanced Managing Editor of *Popular Science Monthly,* boarded a commercial transport plane at New York's LaGuardia Field and flew off to San Francisco on the strangest assignment of his journalistic career.

He was on his way to the vicinity of Bikini Atoll in the Marshall Islands, site of the atom-bomb test. He was one of a carefully selected group of men—from a carefully selected group of publications—who were invited to be present as observers at the dropping of the bomb.

Torrey went well prepared. He had to take the traditional "shots" insisted upon by the military services as barriers against any stray microbes he might encounter on a trip that was expected to last all of two months. He combed through his wardrobe for clothing that would make the heat of the Marshalls, just north of the equator, at least bearable. He took sunglasses, and he borrowed a pair of binoculars from Perry Githens, PSM's editor. And, of course, he took along the mark of his profession, a portable typewriter. He was well equipped when he stepped aboard the official press ship, the *Appalachian* (above), in San Francisco harbor.

He was well equipped in another way. Volta Torrey is as conversant with the atom and nuclear fission as most people are with the neighborhood gossip or the current movies. Son of an engineer, he was named after Alessandro Volta, the 18th-century Italian scientist. He served his journalistic apprenticeship, as have most of the members of PSM's editorial staff, on newspapers. As reporter and desk man, he worked for the *Omaha World-Herald, Chicago Tribune, Cleveland Press, New York Herald Tribune, PM,* and the *Associated Press.* He learned how to handle news in an interpretative way—so the reader would understand it.

Torrey excelled. Not only as a newspaperman but also as a student of world affairs, his contributions to public education were so marked that he was designated a Nieman Fellow for a year's study at Harvard University. From that came a book over his signature, "You and Your Congress," a study of Congress in its relationship to the people. So thorough, so painstaking was the record of his work that he was selected to help write the report of the U. S. Strategic Bombing Survey, in which the civilian looked at air power in World War II.

His bent is toward the scientific. He likes to wallow around in such subjects as the structure of the atom. Before assuming the post of co-managing editor with Fred Otis Newman, he was one of PSM's star reporter-writers.

For Torrey's eyewitness report on Bikini, see pages 77 to 80.

Percy Francis

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